

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

United States Patent and Trademark  
Office  
(Box PCT)  
Crystal Plaza 2  
Washington, DC 20231  
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 01 February 1999 (01.02.99)	
International application No. PCT/NL98/00371	Applicant's or agent's file reference WO 800068-A1
International filing date (day/month/year) 26 June 1998 (26.06.98)	Priority date (day/month/year) 26 June 1997 (26.06.97)
Applicant STASSEN, Hubertus, Ernest, Maria et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:28 December 1998 (28.12.98)☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Catherine Massetti Telephone No.: (41-22) 338.83.38
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## PATENT COOPERATION TREATY

## PCT

REC'D 12 OCT 1999

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## INTERNATIONAL PRELIMINARY EXAMINATION REPORT



(PCT Article 36 and Rule 70)

Applicant's or agent's file reference WO 800068-A1/ho	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/NL98/00371	International filing date (day/month/year) 26/06/1998	Priority date (day/month/year) 26/06/1997
International Patent Classification (IPC) or national classification and IPC C02F11/08		
Applicant BTG BIOMASS TECHNOLOGY GROUP B.V. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.  
  
☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
  
These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand  28/12/1998	Date of completion of this report  0 8. 10. 99
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer  Rumbo, A  Telephone No. +49 89 2399 8407  

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/NL98/00371

## I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

### Description, pages:

1-11 as originally filed

### Claims, No.:

1-19 as received on 20/08/1999 with letter of 16/08/1999

### Drawings, sheets:

1-3 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/NL98/00371

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Yes:	Claims	1-19
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-19
Industrial applicability (IA)	Yes:	Claims	1-19
	No:	Claims	

### 2. Citations and explanations

**see separate sheet**

## VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

**see separate sheet**



**SECTION V (NOVELTY AND INVENTIVE STEP)**

1. The claimed subject-matter meets the requirements of Article 33(2) PCT.

The only concept linking together the wording of the independent claims, namely  
a

gasifier and its use for producing fuel gas by heat treating **in counterflow** an aqueous feed containing carbon atoms is novel in view of the closest prior art documents D1=US-A- 4 113 446 (see abstract, claims 1, 6 and 7; examples 1 to 3) and D2= US-A- 4 166 802 (see abstract, claim 1 and col. 4, lines 3-27). In fact none of the cited documents discloses **the counterflow treatment** of the aqueous feed containing carbon atoms by heat.

2. The claimed subject-matter does not meet the requirements of Article 33(3) PCT.

The absence of at least an objectively solved technical problem as a consequence of the only differentiating technical feature present in the wording of all the independent claims (namely the counterflow heat treatment), the inventive step of the claimed subject-matter cannot be acknowledged.

In fact modifications which do not solve any technical problem can be considered as obvious for the skilled person and therefore not inventive according to Article 33(3) PCT.

At present time nowhere in the application as filed it is disclosed that a technical problem can be solved, by using a counterflow heat treatment which cannot be solved by the technical means referred to in D1 and D2.

Furthermore, the counterflow heating treatments are well known for the skilled person and its use constitutes a selection between two possibilities for heating (co-flow and counter-flow) which can be made by every skilled person without implying any inventive step.

The same comment applies for the technical features of each dependent claim.

**SECTION VIII (CLARITY)**

1. The claimed subject-matter does not meet the requirements of Article 6 PCT.

The presence of three independent claims (#1, #12 and #15) each of them containing technical features completely different from those contained in the wording of the others, does not allow third parties to know which of them are essential for the invention to be performed and which other merely constitute optional technical features.

In fact, the feature "cooling" under point iv) of claim 1 is not disclosed in claim 15.

In the same way, the features high pressure pump (line 5 of claim 12) and the feature from line 12 to line 18 (which reactor... and a second inlet for a fuel) of claim 12 are not disclosed in either claim 1 or 15.

Finally, the presence of a second reactor chamber (lines 6-7), the features of lines 10 to 17 (the first chamber... has been separated from combustible gas) as well as the feature of lines 21 to 28 (the second chamber.... has been subjected to thermal treatment an oxidation) are neither disclosed in claim 1 or claim 12.

The support for the terms "**the arrangement** of inlets and outlets providing for counterflow heat-exchange over the course of treatment" in the wording of claim 12 has not been found in the description and the claims and it has not been cited by the applicant.

In order to overcome the above objection, the applicant is requested:  
first) to file only one independent claim per claim category,  
second) to include **exactly the same technical features** in each independent claim,  
third) to indicate the support in the description or the claims for any amendment.

Failure to do as requested, the clarity of the claimed subject-matter cannot be acknowledged.

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ EP

# PCT

## CHAPTER II

### DEMAND

under Article 31 of the Patent Cooperation Treaty:

The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only

Identification of IPEA		Date of receipt of DEMAND	
<b>Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION</b>		Applicant's or agent's file reference WO 800068-AI/ho	
International application No. PCT/NL98/00371	International filing date (day/month/year) 26/06/1998 (26 June 1998)	(Earliest) Priority date (day/month/year) 26/06/97 (26 June 1997)	
Title of invention Method of thermally treating a carbonaceous material-comprising aqueous fluid and an apparatus therefor			
<b>Box No. II APPLICANT(S)</b>			
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)  BTG Biomass Technology Group B.V. Drienerlolaan 5 7522 NB ENSCHEDE the Netherlands		Telephone No.: (31) 53 489 28 97	
		Facsimile No.: (31) 53 489 31 16	
		Teleprinter No.:	
State (that is, country) of nationality: NL		State (that is, country) of residence: NL	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)  Sparkle International B.V. Boerhaavelaan 18 7555 BC HENGLO the Netherlands			
State (that is, country) of nationality: NL		State (that is, country) of residence: NL	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)  Stassen, Hubertus Ernest Maria Langenkampweg 107 7522 LM ENSCHEDE the Netherlands			
State (that is, country) of nationality: NL		State (that is, country) of residence: NL	
<input checked="" type="checkbox"/> Further applicants are indicated on a continuation sheet.			

## Continuation of Box No. II APPLICANT(S)

*If none of the following sub-boxes is used, this sheet should not be included in the demand.*

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

Penninger, Johannes Mathieu Leonardus  
Boerhaavelaan 18  
7555 BC HENGLO  
the Netherlands

State (that is, country) of nationality:  
NL

State (that is, country) of residence:  
NL

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State (that is, country) of nationality:

State (that is, country) of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State (that is, country) of nationality:

State (that is, country) of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State (that is, country) of nationality:

State (that is, country) of residence:

☐ Further applicants are indicated on another continuation sheet.

**Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE**

The following person is ☒ agent ☐ common representative  
 and ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.  
☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.  
☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

Altenburg, Bernardus Stephanus Franciscus et al.  
 OCTROOIBUREAU LOS EN STIGTER B.V.  
 Weteringschans 96  
 1017 XS AMSTERDAM  
 the Netherlands

Telephone No.:

(31) 20 623 68 32

Facsimile No.:

(31) 20 626 00 07

Teleprinter No.:

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

**Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION****Statement concerning amendments:\***

1. The applicant wishes the international preliminary examination to start on the basis of:

☐ the international application as originally filed

the description

☐ as originally filed☐ as amended under Article 34

the claims

☐ as originally filed☐ as amended under Article 19 (together with any accompanying statement)☐ as amended under Article 34

the drawings

☐ as originally filed☐ as amended under Article 34

2. ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.

3. ☐ The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

\* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

**Language for the purposes of international preliminary examination:**

☐ which is the language in which the international application was filed.

☐ which is the language of a translation furnished for the purposes of international search.

☐ which is the language of publication of the international application.

☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.

**B x N . V ELECTION OF STATES**

The applicant hereby elects all eligible States *(that is, all States which have been designated and which are bound by Chapter II of the PCT)*

excluding the following States which the applicant wishes not to elect:

## Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- |  |   |        |
|--|---|--------|
| 1. translation of international application                              | : | sheets |
| 2. amendments under Article 34   | : | sheets |
| 3. copy (or, where required, translation) of amendments under Article 19 | : | sheets |
| 4. copy (or, where required, translation) of statement under Article 19  | : | sheets |
| 5. letter  | : | sheets |
| 6. other (specify) 789998  | : | sheets |

For International Preliminary Examining Authority use only

received

not received

☐☐☐☐☐☐☐☐☐☐☐☐

The demand is also accompanied by the item(s) marked below:

- |  |   |
|--|---|
| 1. <input type="checkbox"/> fee calculation sheet  | 4. <input type="checkbox"/> statement explaining lack of signature                                  |
| 2. <input type="checkbox"/> separate signed power of attorney                            | 5. <input type="checkbox"/> nucleotide and or amino acid sequence listing in computer readable form |
| 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: | 6. <input type="checkbox"/> other (specify):  |

## Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

Amsterdam, 23 December 1998



Altenburg, Bernardus Stephanus Franciscus et al.

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:

2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):

3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply.

☐ The applicant has been informed accordingly.

4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.

5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:

# PCT

## REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference  
(if desired) (12 characters maximum) WO 800068-A1

<b>Box No. I TITLE OF INVENTION</b> Method of thermically treating a carbon-aceous material-comprising aqueous fluid and an apparatus therefor	
<b>Box No. II APPLICANT</b>	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)	
BTG Biomass Technology Group B.V. Drienerlolaan 5 7522 NB ENSCHEDE the Netherlands	
<input type="checkbox"/> This person is also inventor.	
Telephone No. (31) 53 489 28 97	
Facsimile No. (31) 53 489 31 16	
Teleprinter No.	
State (i.e. country) of nationality: NL	State (i.e. country) of residence: NL
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input checked="" type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box	
<b>Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)</b>	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)	
Sparqle International B.V. Boerhaavelaan 18 7555 BC HENGLO the Netherlands	
This person is: <input checked="" type="checkbox"/> applicant only <input type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)	
State (i.e. country) of nationality: NL	State (i.e. country) of residence: NL
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input checked="" type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box	
<input checked="" type="checkbox"/> Further applicants and/or (further) inventors are indicated on a continuation sheet.	
<b>Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE</b>	
The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: <input checked="" type="checkbox"/> agent <input type="checkbox"/> common representative	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)	
Altenburg, Bernardus Stephanus Franciscus et al OCTROOIBUREAU LOS EN STIGTER B.V. Weteringschans 96 1017 XS AMSTERDAM the Netherlands	
Telephone No. (31) 20 623 68 32	
Facsimile No. (31) 20 626 00 07	
Teleprinter No.	
<input type="checkbox"/> Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.	

## Continuation of Box No. III FURTHER APPLICANTS AND/OR (FURTHER) INVENTORS

If none of the following sub-boxes is used, this sheet is not to be included in the request.

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

Stassen, Hubertus Ernest Maria  
Langenkampweg 107  
7522 LM ENSCHEDE  
the Netherlands

This person is:

☐ applicant only☒ applicant and inventor☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

NL

State (i.e. country) of residence:

NL

This person is applicant for the purposes of:

☐ all designated States☐ all designated States except the United States of America☒ the United States of America only☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

Penninger, Johannes Mathieu Leonardus  
Boerhaavelaan 18  
7555 BC HENGEL  
the Netherlands

This person is:

☐ applicant only☒ applicant and inventor☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

NL

State (i.e. country) of residence:

NL

This person is applicant for the purposes of:

☐ all designated States☐ all designated States except the United States of America☒ the United States of America only☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

This person is:

☐ applicant only☐ applicant and inventor☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

State (i.e. country) of residence:

This person is applicant for the purposes of:

☐ all designated States☐ all designated States except the United States of America☐ the United States of America only☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

This person is:

☐ applicant only☐ applicant and inventor☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

State (i.e. country) of residence:

This person is applicant for the purposes of:

☐ all designated States☐ all designated States except the United States of America☐ the United States of America only☐ the States indicated in the Supplemental Box

Further applicants and/or (further) inventors are indicated on another continuation sheet.



## Box No. V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

## Regional Patent

- ☐ AP ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SZ Swaziland, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☐ EA Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ EP European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☐ OA OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line) .....

## National Patent (if other kind of protection or treatment desired, specify on dotted line):

- |   |   |
|---|---|
| <input type="checkbox"/> AL Albania .....                               | <input type="checkbox"/> LT Lithuania .....                                 |
| <input type="checkbox"/> AM Armenia .....                               | <input type="checkbox"/> LU Luxembourg .....                                |
| <input type="checkbox"/> AT Austria .....                               | <input type="checkbox"/> LV Latvia .....                                    |
| <input type="checkbox"/> AU Australia .....                             | <input type="checkbox"/> MD Republic of Moldova .....                       |
| <input type="checkbox"/> AZ Azerbaijan .....                            | <input type="checkbox"/> MG Madagascar .....                                |
| <input type="checkbox"/> BA Bosnia and Herzegovina .....                | <input type="checkbox"/> MK The former Yugoslav Republic of Macedonia ..... |
| <input type="checkbox"/> BB Barbados .....                              | <input type="checkbox"/> MN Mongolia .....                                  |
| <input type="checkbox"/> BG Bulgaria .....                              | <input type="checkbox"/> MW Malawi .....                                    |
| <input type="checkbox"/> BR Brazil .....                                | <input type="checkbox"/> MX Mexico .....                                    |
| <input type="checkbox"/> BY Belarus .....                               | <input type="checkbox"/> NO Norway .....                                    |
| <input type="checkbox"/> CA Canada .....                                | <input type="checkbox"/> NZ New Zealand .....                               |
| <input type="checkbox"/> CH and LI Switzerland and Liechtenstein .....  | <input type="checkbox"/> PL Poland .....                                    |
| <input type="checkbox"/> CN China .....                                 | <input type="checkbox"/> PT Portugal .....                                  |
| <input type="checkbox"/> CU Cuba .....                                  | <input type="checkbox"/> RO Romania .....                                   |
| <input type="checkbox"/> CZ Czech Republic .....                        | <input type="checkbox"/> RU Russian Federation .....                        |
| <input type="checkbox"/> DE Germany .....                               | <input type="checkbox"/> SD Sudan .....                                     |
| <input type="checkbox"/> DK Denmark .....                               | <input type="checkbox"/> SE Sweden .....                                    |
| <input type="checkbox"/> EE Estonia .....                               | <input type="checkbox"/> SG Singapore .....                                 |
| <input type="checkbox"/> ES Spain .....                                 | <input type="checkbox"/> SI Slovenia .....                                  |
| <input type="checkbox"/> FI Finland .....                               | <input type="checkbox"/> SK Slovakia .....                                  |
| <input type="checkbox"/> GB United Kingdom .....                        | <input type="checkbox"/> SL Sierra Leone .....                              |
| <input type="checkbox"/> GE Georgia .....                               | <input type="checkbox"/> TJ Tajikistan .....                                |
| <input type="checkbox"/> GH Ghana .....                                 | <input type="checkbox"/> TM Turkmenistan .....                              |
| <input type="checkbox"/> GM Gambia .....                                | <input type="checkbox"/> TR Turkey .....                                    |
| <input type="checkbox"/> GW Guinea-Bissau .....                         | <input type="checkbox"/> TT Trinidad and Tobago .....                       |
| <input type="checkbox"/> HU Hungary .....                               | <input type="checkbox"/> UA Ukraine .....                                   |
| <input type="checkbox"/> ID Indonesia .....                             | <input type="checkbox"/> UG Uganda .....                                    |
| <input type="checkbox"/> IL Israel .....                                | <input checked="" type="checkbox"/> US United States of America .....       |
| <input checked="" type="checkbox"/> JP Japan .....                      | <input type="checkbox"/> UZ Uzbekistan .....                                |
| <input type="checkbox"/> KE Kenya .....                                 | <input type="checkbox"/> VN Viet Nam .....                                  |
| <input type="checkbox"/> KG Kyrgyzstan .....                            | <input type="checkbox"/> YU Yugoslavia .....                                |
| <input type="checkbox"/> KP Democratic People's Republic of Korea ..... | <input type="checkbox"/> ZW Zimbabwe .....                                  |
| <input type="checkbox"/> KR Republic of Korea .....                     |   |
| <input type="checkbox"/> KZ Kazakhstan .....                            |   |
| <input type="checkbox"/> LC Saint Lucia .....                           |   |
| <input type="checkbox"/> LK Sri Lanka .....                             |   |
| <input type="checkbox"/> LR Liberia .....                               |   |
| <input type="checkbox"/> LS Lesotho .....                               |   |

Check-boxes reserved for designating States (for the purposes of a national patent) which have become party to the PCT after issuance of this sheet:

- ☐ .....
- ☐ .....
- ☐ .....

In addition to the designations made above, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except the designation(s) of .....

The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)

**Box No. VI PRIORITY CLAIM**Further priority claims are indicated in the Supplemental Box ☐

The priority of the following earlier application(s) is hereby claimed:

Country (in which, or for which, the application was filed)	Filing Date (day/month/year)	Application No.	Office of filing (only for regional or international application)
item (1) NL	26.06.1997 (June 26, 1997)	1006404	
item (2)			
item (3)			

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 3. claims : 4 sheets  
 4. abstract : 1 sheets  
 5. drawings : 3 sheets  
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Figure No. \_\_\_\_\_ of the drawings (if any) should accompany the abstract when it is published.

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Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Amsterdam, 24 June 1998



Altenburg, Bernardus Stephanus Franciscus et al.

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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>C02F 11/08, C10J 3/00</b>	<b>A1</b>	(11) International Publication Number: <b>WO 99/00334</b> (43) International Publication Date: 7 January 1999 (07.01.99)
<p>(21) International Application Number: PCT/NL98/00371</p> <p>(22) International Filing Date: 26 June 1998 (26.06.98)</p> <p>(30) Priority Data: 1006404 26 June 1997 (26.06.97) NL</p> <p>(71) Applicants (for all designated States except US): BTG BIOMASS TECHNOLOGY GROUP B.V. [NL/NL]; Drienerlolaan 5, NL-7522 NB Enschede (NL). SPARQLE INTERNATIONAL B.V. [NL/NL]; Boerhaavelaan 18, NL-7555 BC Hengelo (NL).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): STASSEN, Hubertus, Ernest, Maria [NL/NL]; Langenkampweg 107, NL-7522 LM Enschede (NL). PENNINGER, Johannes, Mathieu, Leonardus [NL/NL]; Boerhaavelaan 18, NL-7555 BC Hengelo (NL).</p> <p>(74) Agent: ALTENBURG, Bernardus, Stephanus, Franciscus; Octrooibureau Los en Stigter B.V., Weteringschans 96, NL-1017 XS Amsterdam (NL).</p>		<p>(81) Designated States: JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p><b>Published</b> <i>With international search report. In English translation (filed in Dutch).</i></p>
<p>(54) Title: METHOD OF THERMICALLY TREATING A CARBONACEOUS MATERIAL-COMPRISING AQUEOUS FLUID AND AN APPARATUS THEREFOR</p>		
<p>(57) Abstract</p> <p>The invention relates to a method of the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified, to yield a combustible gas. According to the invention the conversion of the carbonaceous material into combustible gas is incomplete, and the not yet converted carbonaceous material is oxidized through the supply of oxygen. The heat produced during oxidation is utilized to sustain the gasification process. The invention also relates to an installation suitable for carrying out the method.</p>		

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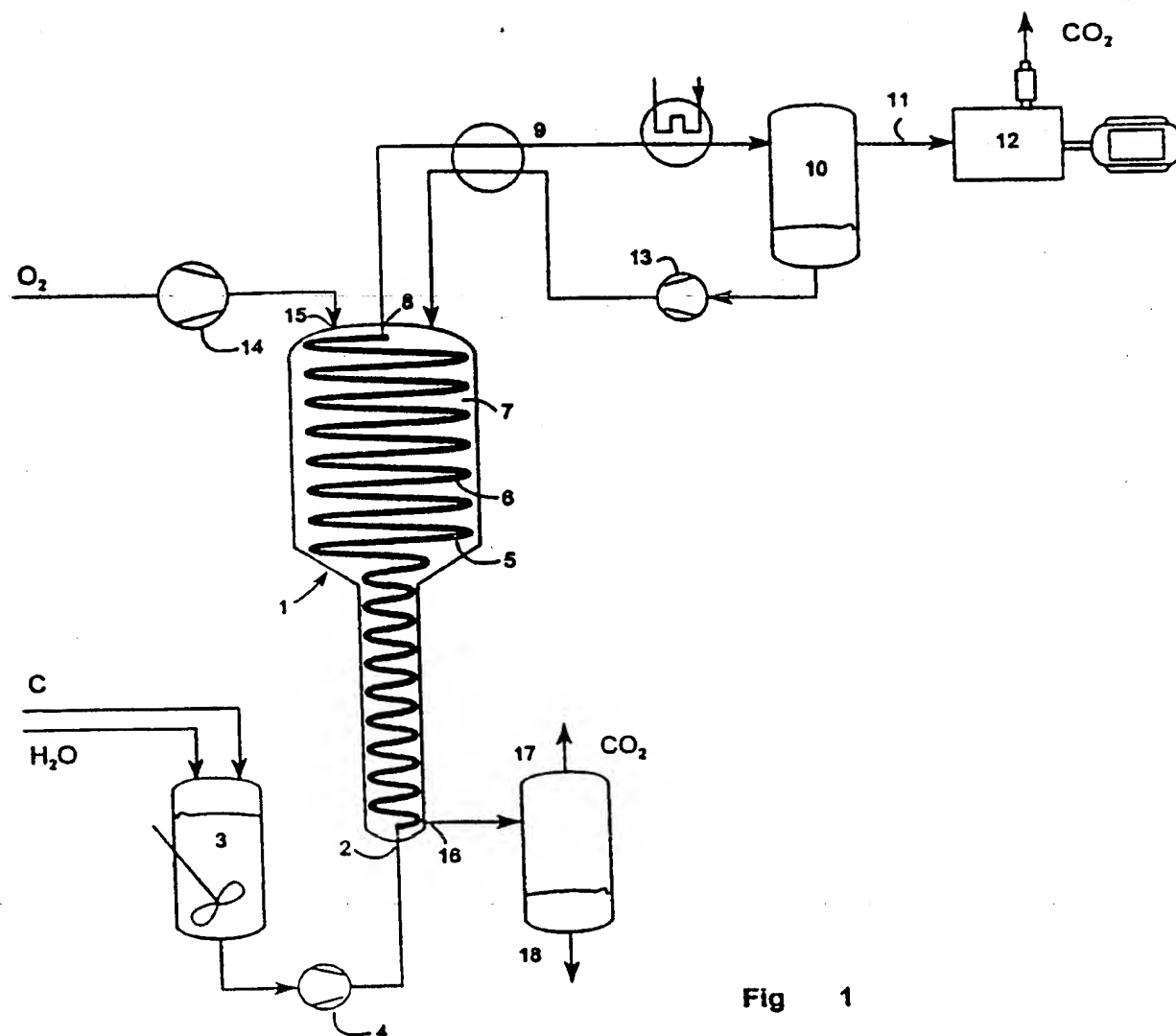


Fig 1

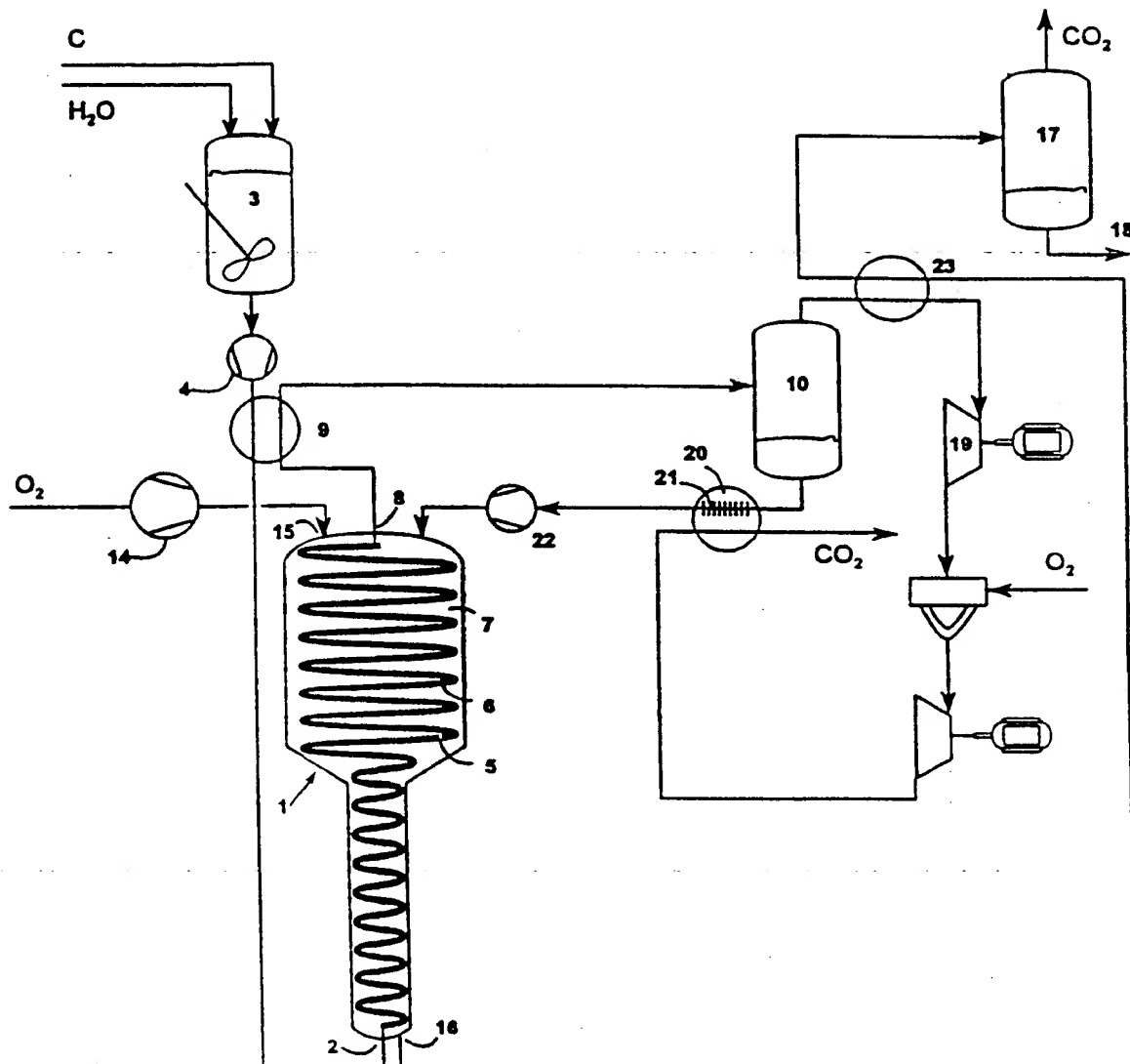


Fig 2

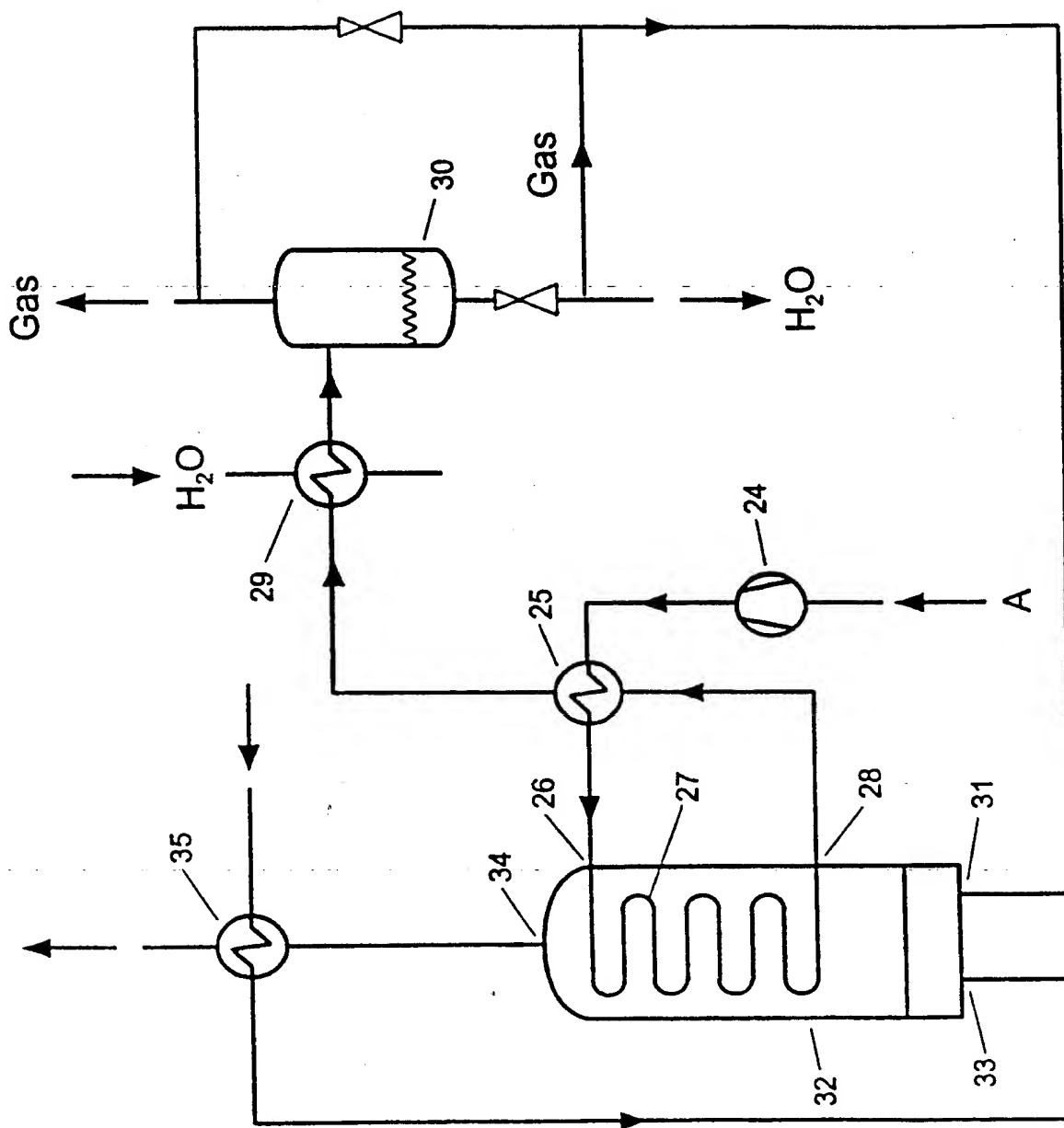


Fig. 3



## INTERNATIONAL SEARCH REPORT

International Application No

PCT/NL 98/00371

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 C02F11/08 C10J3/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C02F C10J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	EP 0 051 817 A (HOECHST) 19 May 1982 see page 5, line 10 - page 6, line 29 ---	1 5
Y	US 4 166 802 A (SLATER) 4 September 1979 see column 3, line 43 - column 4, line 62 ---	1
A	US 4 113 446 A (MODELL) 12 September 1978 see column 8-10; claims 1-10 ---	1,2
A	NL 1 000 967 C (HOMALIMA) 1 April 1997 see the whole document ---	1,11
A	GEURDEN: "SUPERKRITISCHE BEHANDELING VAN VARKENS DRIJFMEST" PROCESSTECHNIEK, vol. 4, no. 43, April 1988, pages 35-37, XP002057876 see the whole document ---	1,2,11
	--- -/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

1 October 1998

Date of mailing of the international search report

12/10/1998

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# INTERNATIONAL SEARCH REPORT

Inter      nal Application No  
PCT/NL 98/00371

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 604 957 A (CEDRQUIST) 12 August 1986 see column 6-8; claims 1,2 ---	1
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			US 4869833 A	26-09-1989



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>C02F 11/08, C10J 3/00</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 99/00334</b> <b>(43) International Publication Date:</b> 7 January 1999 (07.01.99)
<b>(21) International Application Number:</b> PCT/NL98/00371 <b>(22) International Filing Date:</b> 26 June 1998 (26.06.98)  <b>(30) Priority Data:</b> 1006404                      26 June 1997 (26.06.97)                      NL  <b>(71) Applicants (for all designated States except US):</b> BTG BIOMASS TECHNOLOGY GROUP B.V. [NL/NL]; Drienerlolaan 5, NL-7522 NB Enschede (NL). SPARQLE INTERNATIONAL B.V. [NL/NL]; Boerhaavelaan 18, NL-7555 BC Hengelo (NL).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> STASSEN, Hubertus, Ernest, Maria [NL/NL]; Langenkampweg 107, NL-7522 LM Enschede (NL). PENNINGER, Johannes, Mathieu, Leonardus [NL/NL]; Boerhaavelaan 18, NL-7555 BC Hen- gelo (NL).  <b>(74) Agent:</b> ALTENBURG, Bernardus, Stephanus, Franciscus; Octrooibureau Los en Stigter B.V., Weteringschans 96, NL-1017 XS Amsterdam (NL).		<b>(81) Designated States:</b> JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>In English translation (filed in Dutch).</i>
<b>(54) Title:</b> METHOD OF THERMICALLY TREATING A CARBONACEOUS MATERIAL-COMPRISING AQUEOUS FLUID AND AN APPARATUS THEREFOR  <b>(57) Abstract</b>  The invention relates to a method of the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified, to yield a combustible gas. According to the invention the conversion of the carbonaceous material into combustible gas is incomplete, and the not yet converted carbonaceous material is oxidized through the supply of oxygen. The heat produced during oxidation is utilized to sustain the gasification process. The invention also relates to an installation suitable for carrying out the method.		

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Method of thermically treating a carbonaceous material-comprising aqueous fluid and an apparatus therefor

The present invention relates to a method of the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified, to yield a combustible gas.

5           The gasification of carbonaceous material such as coal in the presence of steam and a limited amount of oxygen has been known in the field for some time. Due to the combustion of a portion of the coal in a suspension of coal in water, the suspension becomes very hot. As a  
10       result, at a temperature of 1000-1200°C and a pressure of approximately 50-100 atmospheres, a carbon monoxide- and hydrogen-comprising combustible gas is produced.

          The object of the present invention is to improve the known method and in particular its energy efficiency.  
15       An additional object according to the invention is to improve the control of the thermal treatment.

          The method according to the invention comprises the following steps:

- 20           i) feeding the aqueous fluid comprising carbonaceous material to be gasified to a reactor comprising a course of treatment;
- ii) transferring heat to the carbonaceous material-comprising aqueous fluid in counterflow;
- 25           iii) the gasification of the carbonaceous material in the course of treatment at an elevated temperature in the presence of water, to yield a product stream comprising combustible gas and a carbonaceous material-depleted aqueous fluid; and
- 30           iv) cooling the product stream until the carbonaceous material-depleted aqueous fluid at least partially comprises a carbonaceous material-depleted aqueous fluid and the separation of the combustible gas from the carbonaceous material-depleted aqueous fluid.

          This ensures a high conversion of (a continuous  
35       stream) carbonaceous material to be gasified into combust-

ible gas, the combustible gas moreover being of very high quality having a high hydrogen content and a low CO-content. Step iii) is carried out under low-oxygen or anoxic conditions. More specifically, no oxygen is added.

5           According to a preferred embodiment the gasification in step ii) is carried out at a temperature and pressure equal to or higher than the critical temperature and pressure of water.

10           At critical conditions complete mixing is realized between the formed combustible gas and water, which ensures good heat transfer to carbonaceous material still to be gasified.

15           In step iii) gasification occurs preferably at a temperature higher than 400°C, in particular at a temperature higher than 500°C.

          This ensures a substantially total conversion of all the carbonaceous material initially present.

20           According to a further preferred embodiment the product stream in step iv) is cooled by feeding it in counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

          In this manner the temperature of the carbonaceous material-depleted aqueous fluid can be elevated in an energy-efficient fashion.

25           According to an interesting embodiment the carbonaceous material-depleted aqueous fluid is heated, oxygen-comprising gas is introduced into the heated fluid, oxygen is reacted with the carbonaceous material present in the depleted aqueous fluid producing heat, which heat is transferred to an aqueous fluid comprising carbonaceous material to be gasified.

30           According to this embodiment of the invention, subsequent to the separation of combustible gas, oxygen is supplied to the carbonaceous material-depleted aqueous fluid. This causes carbonaceous material still present in the fluid to be combusted, yielding heat which is utilized to sustain the gasification process. The heat is released at a location where it can be transferred efficiently. Preheating the depleted fluid prior to the addition of

35

oxygen provides an efficient manner of achieving a very high temperature. This is self-regulating. For instance, insufficient gasification of carbonaceous material at the onset means that more carbonaceous material is left over for oxidation, resulting in the elevation of the temperature, which in turn promotes gasification. Conversely, if too much carbonaceous material is gasified, less carbonaceous material is left over for oxidation and temperature elevations are prevented. If the depleted fluid is heated to above the critical temperature and pressure, the oxygen can easily be mixed completely homogenously with the depleted fluid.

According to a preferred embodiment the combustible gas is combusted in a combustion installation to yield electricity and heat.

In this manner the energy contents of the carbonaceous material to be gasified, which material may be a waste product, is utilized.

According to a very favourable embodiment, a portion of the combustible gas formed is used to attain the elevated temperature described in step ii).

This fuel is available on the spot.

Subsequent heating is effectuated in particular by counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

This provides an efficient utilization of energy.

By the method according to the invention a variety of carbonaceous materials suspended in water can be gasified, such as shredded biomass, coal or peat. An interesting application relates to the gasification of semi-liquid manure and manure suspended in water.

The treatment of semi-liquid manure or manure by the method according to the invention means for one thing the utilization of its energy-content, and for another thing the resolution of problems regarding manure storage, environmental pollution and the spreading of disease.

The invention also relates to an apparatus for the application of the method according to the invention.



A first installation for the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified to yield a combustible gas and an aqueous fluid poor in carbonaceous material to be gasified comprises a high-pressure pump for feeding under high pressure the aqueous fluid comprising carbonaceous material to be gasified to an elongated tubular reactor having a first and a second end, wherein the first end is provided with an inlet for the aqueous fluid comprising carbonaceous material to be gasified, and the second end is provided with an outlet for the carbonaceous material-depleted aqueous fluid, which reactor is provided in a chamber of an incinerator, which chamber is separated from the lumen of the tubular reactor by means of a heat-conducting reactor wall defining a course of treatment, at the side of the outlet of the tubular reactor the incinerator is provided with a first inlet for oxygen-comprising gas and a second inlet for a fuel, and at the side of the inlet of the reactor the chamber is provided with an exhaust for combustion products, and the exhaust of the reactor is connected to means for the separation of combustible gas formed as a result of gasification, and carbonaceous material-depleted aqueous fluid.

This provides various ways of efficiently utilizing heat energy present in the combustion products. The hot combustion products can be used for the production of steam, and optionally of electricity. It is also possible to fire the incinerator under a pressure of, for instance, 20 bars. It is then possible to utilize the combustion products for the generation of electricity by means of a turbine. In such a case the incinerator is preferably fired utilizing the gas formed by the method under high pressure. The incinerator may be a fluid bed in which the bed material is, for instance, aluminium oxide. This promotes the transfer of heat to the reactor wall. The fuel may be gaseous, liquid or solid. The bed material may comprise a catalyst in order to, for instance, keep the nitrogen emissions low. Alternatively, the incinerator itself may be a reactor in which at high temperatures an

exothermal conversion takes place, yielding a desired product. The preparation of such products may include, for instance, ethane or synthesis gas resulting from the partial oxidation of methane. The gas formed is worked up in a manner known in itself. As source for methane worked up combustibile gas obtained by the method according to the invention may be used.

According to a preferred embodiment, the installation comprises a heat exchanger conducting the carbonaceous material-depleted fluid coming from the tubular reactor in counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

Such an installation is capable of gasifying carbonaceous material in a very energy-efficient manner.

According to a further favourable embodiment the installation comprises a heat exchanger for conducting combustion products coming from the incinerator in counterflow to oxygen-comprising gas to be supplied to the first inlet.

This means that the reactor can reach very high temperatures, so that virtually complete a conversion of carbonaceous material into gas is guaranteed. Further, the very hot combustion gasses leaving the exhaust can be utilized for the production of steam, for instance for the generation of electricity.

In accordance with the invention, an alternative installation for the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified to yield a combustibile gas and an aqueous fluid poor in carbonaceous material to be gasified, comprises a gasification reactor having a substantially elongated first chamber and a substantially elongated second chamber, the first chamber comprising an inlet opening for the thermal treatment of aqueous fluid comprising carbonaceous material to be gasified, the first chamber and the second chamber being separated by a heat-conducting wall, which heat-conducting wall defines a course of treatment along which, after separation of the combustibile gas, the aqueous fluid comprising carbonaceous material to be gasified is conducted in

counterflow to an aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material to be gasified and has been separated from combustible gas, the installation further comprises means for separating the combustible gas and the aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material, as well as an exhaust for the combustible gas, further the second chamber is provided with an inlet opening for the supply of compressed oxygen-comprising gas via a pipe and by means of a pumping organ to the aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material and which has separated from the combustible gas, and an outlet for a fluid which has been subjected to thermal treatment and oxidation.

Such an installation makes an energy-efficient, self-regulating thermal treatment of fluid comprising carbonaceous material to be gasified possible.

According to a favourable embodiment the means for separating the combustible gas from the aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material, comprise a heat exchanger.

This allows a more efficient separation of the combustible gas from the carbonaceous material-depleted aqueous fluid.

Preferably the installation according to the invention comprises means for the combustion of the combustible gas, yielding electricity and heat.

This makes it possible to obtain high-grade energy from waste material which, from an environmental point of view is awkward to dispose of, such as manure but also vegetable, fruit and garden waste, activated sludge, grass cuttings from verges, etc.

According to a further favourable embodiment of the installation according to the invention, the installation further comprises a heat-conducting surface for transferring to at least one chamber heat released during combustion.

According to a preferred embodiment the first chamber surrounds in the longitudinal direction substantially the second chamber and the heat-conducting surface surrounds in the longitudinal direction substantially the first chamber.

Such installations are more energy-efficient.

The invention will now be illustrated by means of the figure legends below and with reference to the appended drawing, in which

Fig. 1 is a schematic illustration of a first installation suitable for carrying out the method in accordance with the invention;

Fig. 2 schematically illustrates a portion of a second installation suitable for carrying out the method in accordance with the invention; and

Fig. 3 is a schematic illustration of a third installation suitable for the application of the method according to the invention.

Reference is now made to Fig. 1, in which a reactor 1 is shown having an inlet 2 for a carbonaceous material-comprising aqueous fluid to be thermally treated. This fluid may be prepared in a vessel 3 into which water ( $H_2O$ ) and a carbonaceous material (C) are introduced. This carbonaceous material may be shredded biomass, coal, manure, etc. By means of a pump 4 a solution or suspension of the carbonaceous material-comprising aqueous fluid to be thermally treated is introduced into the reactor via the inlet 2. The inlet 2 debouches into an elongated first chamber 5 which is separated from a second chamber 7 by a heat-conducting wall 6. In the first chamber 5, at least a portion of the carbonaceous material is gasified yielding a mixture of combustible gas and a carbonaceous material-depleted fluid. In the embodiment shown, this mixture leaves the reactor 1 via outlet 8 and enters a heat exchanger 9, in which the mixture is cooled. This cooling process promotes the separation of combustible gas from carbonaceous material-depleted fluid. In vessel 10 the depleted fluid is separated from the combustible gas. Via a pipe 11, this combustible gas may be transported to an

installation 12, which installation 12 is suitable for the generation of electricity. The installation 12 may comprise a turbine, a combustion engine or, in combination with a reformer for increasing the hydrogen content in the gas, a fuel cell.

The carbonaceous material-depleted fluid from vessel 10 may be heated via the heat exchanger 9 and, with the aid of pump 13, introduced under increased pressure into the second chamber 7.

Via a pump 14 and inlet 15, an oxygen-comprising gas, such as preferably air, is introduced into the second chamber 7. The oxygen reacts with carbonaceous material still present in the depleted fluid, yielding heat. Via the heat-exchanging wall 6, this heat is transferred to the aqueous fluid comprising carbonaceous material to be gasified. It is preferred that in the second chamber near the inlet 15 super critical conditions prevail to allow ready and homogenous mixing of oxygen and carbonaceous material-depleted fluid.

The fact that the energy necessary for gasification is provided by oxidation of the remaining carbonaceous material, affords a highly self-regulatory thermal treatment process.

The liquid that has been subjected to oxidation by oxygen so that, in essence, it no longer comprises any (oxidizable) carbonaceous material, moves in counterflow to the aqueous fluid comprising carbonaceous material to be gasified, thereby efficiently transferring heat. The cooled, essentially carbonaceous material-free fluid leaves the reactor 1 via outlet 16 and flows, in the embodiment shown, into a vessel 17 to separate clean water 18, that may be discharged or used for the preparation of a carbonaceous material-containing aqueous fluid, from inert gasses such as carbon dioxide and possibly nitrogen gas formed during oxidation.

Preferably the carbonaceous material-comprising aqueous fluid to be thermally treated comprises a catalyst to promote the formation of combustible gas. This catalyst may be an ion or a precious metal particle which, if the

clean water from vessel 17 is to be reused for the preparation of suspension, may be allowed to go through the cycle once or several times more, until the clean water contains too many anorganic salts originating from the carbonaceous starting material so that part of, or all the water has to be discharged or improved.

Optionally, the installation according to the invention may also comprise means (not shown) for the utilization of the pressure energy. This may be utilized for the generation of energy or to aid in returning the carbonaceous material-depleted liquid to the reactor 1, more specifically to its second chamber 7. For the return to the second chamber 7 it is, for example, possible to utilize the pressure energy from the gas leaving the vessel 10. Similarly, the pressure energy from the liquid leaving the vessel 17 may also be utilized to relieve the pump 4 or for the generation of electricity.

An alternative embodiment of an installation according to the invention is schematically illustrated in Fig. 2. After the mixture described above has left outlet 8, it is cooled in heat exchanger 9. The heat energy being released is utilized for heating the carbonaceous material-comprising aqueous liquid to be thermally treated in heat exchanger 9'. Advantageously, heat exchanger 9 and 9' are one and the same heat exchanger. The cooled mixture, being highly compressed, may be allowed to expand over a turbine 19 to generate electrical energy. By supplying an oxygen-comprising gas, usually air, the gas may then be combusted. This may be done in a second turbine 20, producing heat and electricity. In the embodiment illustrated, the still hot combustion gasses from turbine 20 are utilized in a heat exchanger, for in counterflow heating of carbon-depleted liquid from vessel 10. With the aid of a pump 22, this liquid is transported to the second chamber 7. Between the vessel 10 and the turbine 19 a heat exchanger 23 may be placed, for heating combustible gas from the vessel 10, which allows a further increase of the pressure and consequently of the performance of turbine 19. The necessary heat is preferably supplied by the

stream leaving the second chamber 7 via heat exchanger 23', which is preferably one and the same as heat exchanger 23.

5        Within the scope of the present invention, the combustion gasses may also be supplied to a further installation for the thermal treatment of a liquid, such as a liquid comprising carbonaceous material to be gasified, which installation possesses a heat-exchanging partition between a first and a second chamber, as well as a heat-exchanging surface for transferring heat from combustion  
10       gas to colder liquid.

      According to an important alternative embodiment of the method in accordance with the invention the supply of oxygen is omitted if the gasification takes place at a  
15       temperature and a pressure well above the critical temperature and pressure of water. For this purpose an installation of the kind illustrated in Fig. 3 may be used which has a capacity of 100 MW relating to the energy contents of the carbonaceous material. The installation comprises a high-pressure pump 24 by means of which a sludge  
20       A of shredded biomass, such as wood flour having a solid content of 20%, is transported at a pressure of 30 MPa, via a heat exchanger 25 and an inlet 26 into a tubular reactor 27. The tubular reactor 27 is suitably made of  
25       Incoloy 625 and has a (total) length of, for example, 725 m and a surface area of 114 m<sup>2</sup>. The carbonaceous material-depleted stream leaving the reactor 27 via outlet 28 is led through the heat exchanger 25 in counterflow to the sludge A and is optionally cooled further to a temperature of 25°C, for example by using cooling water in  
30       heat exchanger 29. The combustible gas formed in the reactor 27 is separated from the carbonaceous material-depleted stream by means of a gas/liquid separator 30. By lowering the pressure above said depleted stream to, for  
35       example, atmospheric pressure, it is possible to recover more gas from the depleted stream which may be used, for example, for heating the sludge A to be gasified further. The prevailing high pressure makes it advantageous to use a membrane for the separation of hydrogen from the stream.

Via an inlet 31, the remaining gas stream may be fed to an incinerator 32 having a height of 10-15 m, in which the reactor 27 is provided. The incinerator 32 also comprises an inlet 33 for an oxygen-comprising fuel such as air. As shown in Fig. 3, the sludge to be gasified is led in counterflow to the hot gasses released during combustion. In the embodiment shown, the hot gasses leave the incinerator 32 via an exhaust 34 and their energy contents are used for heating air which is to be supplied to the incinerator 32 via inlet 33, by counter-flowing the hot gasses to the air in the heat exchanger 35. A suitable installation is provided with, for example, a heat exchanger 25 having a surface area of 888 m<sup>2</sup> and a heat transfer coefficient of 1200 W/m<sup>2</sup>.K and is fed at a rate of 32 kg dry matter (in 128 kg water) per second. In addition, abstaining from the use of oxygen-comprising air results in the combustible gas having only a low nitrogen content. Partly for that reason, the gas has a high caloric value so that it can be applied more generally. The temperature required for the gasification of the carbonaceous material can be determined quite easily by a person skilled in the art.

In the installation described above, the solid content is suitably at least 10% and preferably at least 20%, such as at least 30%.



CLAIMS

1. A method of the thermal treatment of an aqueous  
5 fluid comprising carbonaceous material to be gasified, to  
yield a combustible gas, which method comprises the fol-  
lowing steps:

i) feeding the aqueous fluid comprising carbon-  
aceous material to be gasified to a reactor comprising a  
10 course of treatment;

ii) transferring heat to the carbonaceous material-  
comprising aqueous fluid in counterflow;

iii) the gasification of the carbonaceous material  
in the course of treatment at an elevated temperature in  
15 the presence of water, to yield a product stream compris-  
ing combustible gas and a carbonaceous material-depleted  
aqueous fluid; and

iv) cooling the product stream until the carbona-  
ceous material-depleted aqueous fluid at least partially  
20 comprises a carbonaceous material-depleted aqueous fluid  
and the separation of the combustible gas from the carbon-  
aceous material-depleted aqueous fluid.

2. A method according to claim 1, characterized in  
that the gasification in step iii) is carried out at a  
25 temperature and pressure equal to or higher than the cri-  
tical temperature and pressure of water.

3. A method according to claim 2, characterized in  
that the gasification in step iii) is carried out at a  
temperature higher than 400°C, preferably higher than  
30 500°C.

4. A method according to one of the preceding  
claims, characterized in that cooling of the product  
stream in step iv) is carried out by feeding it in  
counterflow to the aqueous fluid comprising carbonaceous  
35 material to be gasified.

5. A method according to one of the claims 1-3,  
characterized in that the carbonaceous material-depleted  
aqueous fluid is heated, oxygen-comprising gas is intro-  
duced into the heated fluid, oxygen is reacted with the

carbonaceous material present in the depleted aqueous fluid producing heat, which heat is transferred to an aqueous fluid comprising carbonaceous material to be gasified.

5           6. A method according to one of the preceding claims, characterized in that a portion of the combustible gas formed is used to attain the elevated temperature described in step ii).

10           7. A method according to one of the preceding claims, characterized in that subsequent heating is effected by counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

15           8. A method according to one of the preceding claims, characterized in that the heat supplied to the fluid comprising material to be gasified stems from an exothermal synthesis reaction.

          9. A method according to claim 6 or 7, characterized in that the combustible gas is combusted in a combustion installation to yield electricity and heat.

20           10. A method according to one of the preceding claims, characterized in that the carbonaceous material to be gasified is biomass.

          11. A method according to claim 10, characterized in that the biomass is selected from the group comprising semi-liquid manure and manure suspended in water.

25           12. An installation for the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified to yield a combustible gas and an aqueous fluid poor in carbonaceous material to be gasified comprising a high-pressure pump for feeding under high pressure the aqueous fluid comprising carbonaceous material to be gasified to an elongated tubular reactor having a first and a second end, wherein the first end is provided with an inlet for the aqueous fluid comprising carbonaceous material to be gasified, and the second end is provided with an outlet for the carbonaceous material-depleted aqueous fluid, which reactor is provided in a chamber of an incinerator, which chamber is separated from the lumen of the tubular reactor by means of a heat-conducting reactor

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wall defining a course of treatment at the side of the outlet of the tubular reactor the incinerator is provided with a first inlet for oxygen-comprising gas and a second inlet for a fuel, and at the side of the inlet of the reactor the chamber is provided with an exhaust for combustion products, and the exhaust of the reactor is connected to means for the separation of combustible gas formed as a result of gasification, and carbonaceous - material-depleted aqueous fluid.

10           13. An installation according to claim 12, characterized in that the installation comprises a heat exchanger conducting the carbonaceous material-depleted fluid coming from the tubular reactor in counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

15           14. An installation according to claim 12 or 13, characterized in that the installation comprises a heat exchanger for conducting combustion products coming from the incinerator in counterflow to oxygen-comprising gas to be supplied to the first inlet.

20           15. An installation for the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified to yield a combustible gas and a carbonaceous material-depleted aqueous fluid to be gasified, which  
25           installation comprises a gasification reactor having a substantially elongated first chamber and a substantially elongated second chamber, the first chamber comprising an inlet opening for the thermal treatment of aqueous fluid comprising carbonaceous material to be gasified, the first  
30           chamber and the second chamber being separated by a heat-conducting wall, which heat-conducting wall defines a course of treatment along which, after separation of the combustible gas, the aqueous fluid comprising carbonaceous material to be gasified is conducted in counterflow to an  
35           aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material to be gasified and has been separated from combustible gas, the installation further comprises means for separating the combustible gas and the aqueous fluid which, as a result of thermal treat-

ment, has become poor in carbonaceous material, as well as an exhaust for the combustible gas, further the second chamber is provided with an inlet opening for the supply of compressed oxygen-comprising gas via a pipe and by means of a pumping organ to the aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material and which has separated from the combustible gas, and an outlet for a fluid which has been subjected to thermal treatment and oxidation.

10           16. An installation according to claim 15, characterized in that the means for separating the combustible gas and the aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material, comprise a heat exchanger.

15           17. An installation according to claim 15 or 16, characterized in that the installation comprises means for the combustion of the combustible gas to yield electricity and heat.

20           18. An installation according to claim 17, characterized in that the installation further comprises a heat-conducting surface for transferring to at least one chamber heat released during combustion.

25           19. An installation according to claim 18, characterized in that the first chamber surrounds in the longitudinal direction substantially the second chamber and the heat-conducting surface surrounds in the longitudinal direction substantially the first chamber.

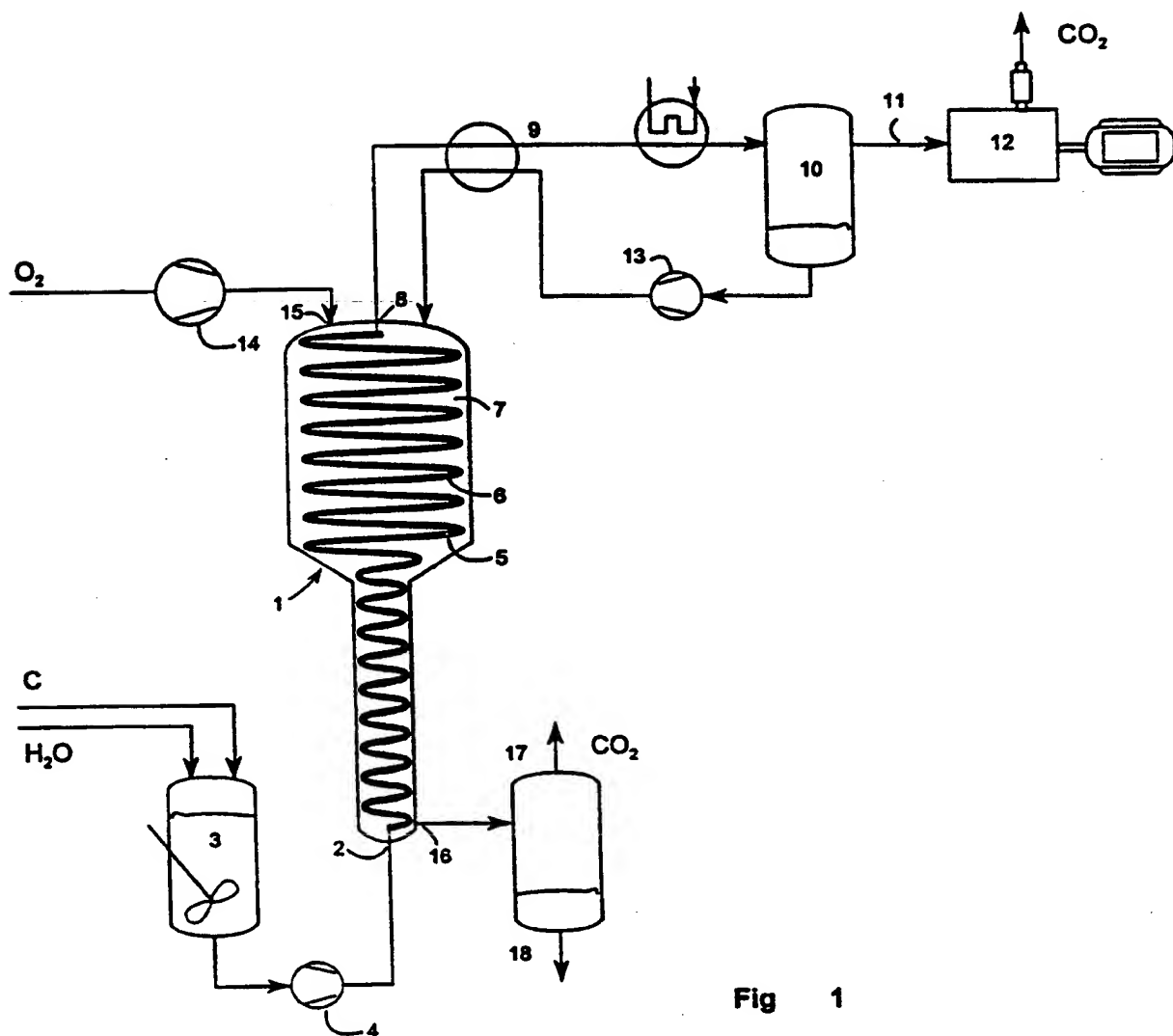


Fig 1

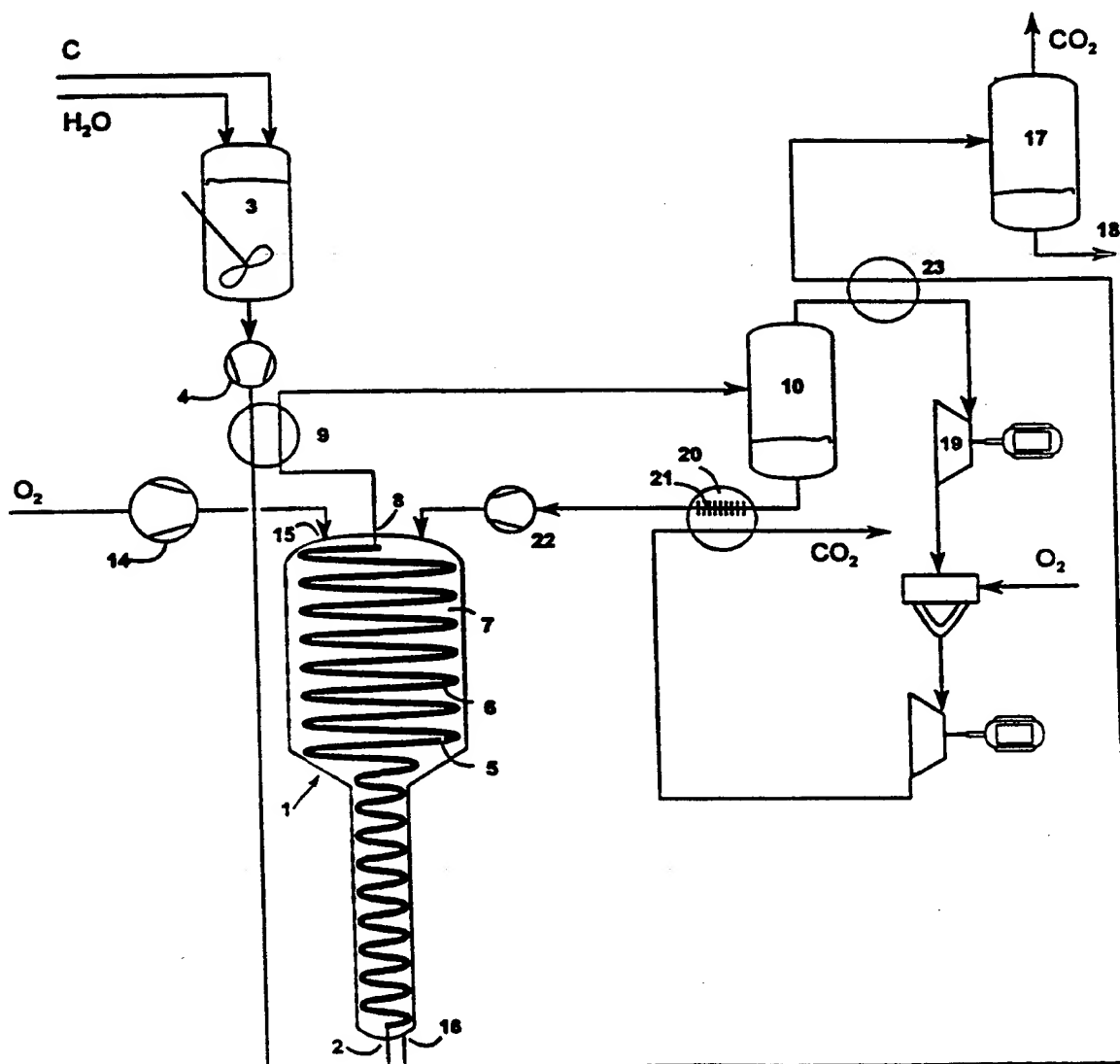


Fig 2

3/3

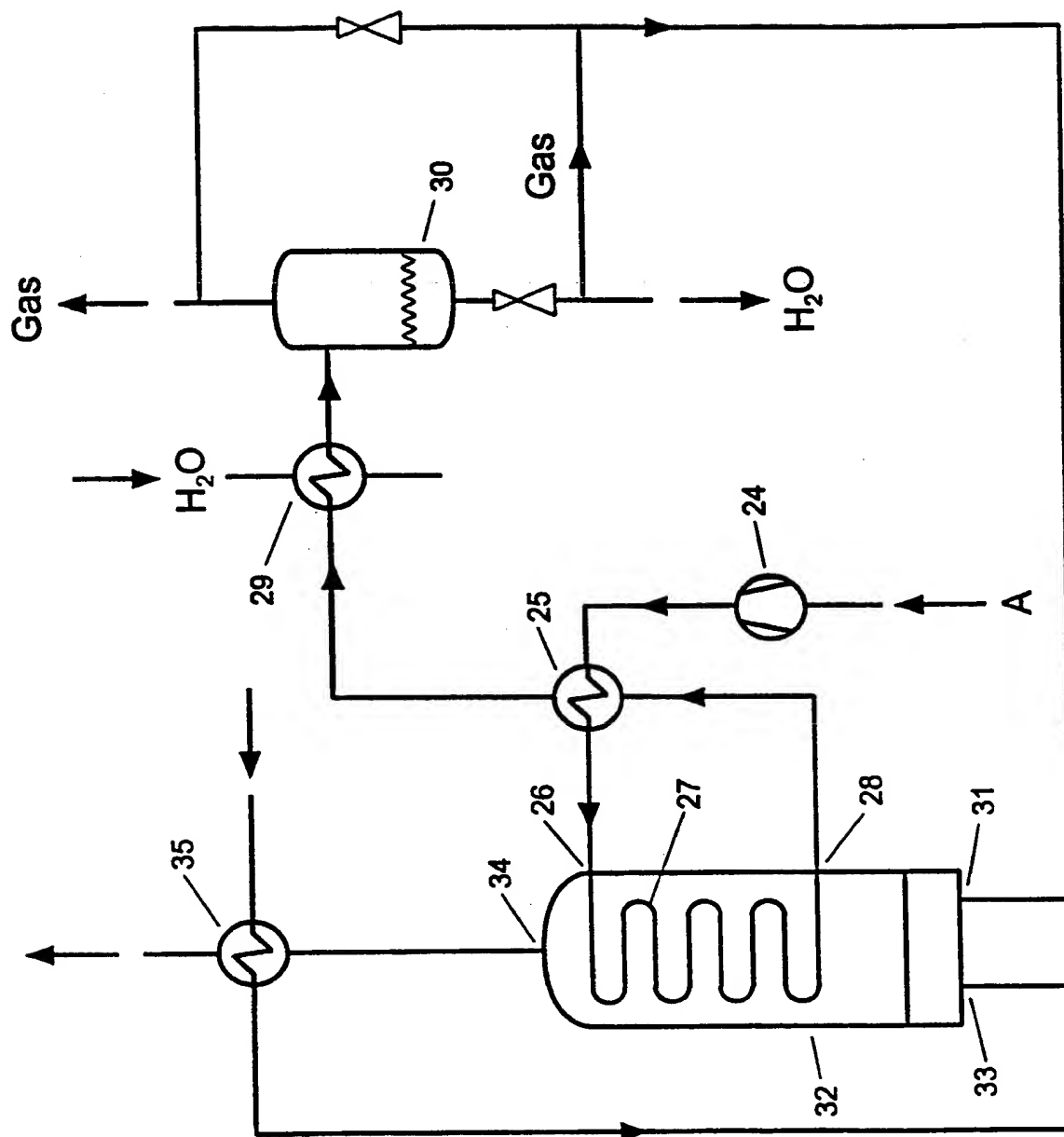


Fig. 3

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/NL 98/00371

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C02F11/08 C10J3/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C02F C10J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 051 817 A (HOECHST) 19 May 1982	1
A	see page 5, line 10 - page 6, line 29	5
Y	US 4 166 802 A (SLATER) 4 September 1979	1
	see column 3, line 43 - column 4, line 62	
A	US 4 113 446 A (MODELL) 12 September 1978	1,2
	see column 8-10; claims 1-10	
A	NL 1 000 967 C (HOMALIMA) 1 April 1997	1,11
	see the whole document	
A	GEURDEN: "SUPERKRITISCHE BEHANDELING VAN VARKENDRIJFMEST" PROCESSTECHNIEK, vol. 4, no. 43, April 1988, pages 35-37, XP002057876 see the whole document	1,2,11
	-/--	



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

\* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

1 October 1998

Date of mailing of the international search report

12/10/1998

Name and mailing address of the ISA

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# INTERNATIONAL SEARCH REPORT

Inter national Application No  
PCT/NL 98/00371

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 604 957 A (CEDRQUIST) 12 August 1986 see column 6-8; claims 1,2 ---	1
A	US 5 240 619 A (COPA) 31 August 1993 see column 7-8; claims 1-16 ---	1,2
A	US 3 060 118 A (SCHOEFFEL) 23 October 1962 ---	
A	EP 0 240 340 A (VERTECH TREATMENT SYSTEMS) 7 October 1987 see page 12; claim 7 -----	12,15,17

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/NL 98/00371

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 51817	A	19-05-1982	DE 3042193 A	24-06-1982
			US 4347144 A	31-08-1982
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			AU 4607579 A	25-10-1979
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			NL 8602374 A	02-11-1987
			US 4869833 A	26-09-1989

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

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NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT

(PCT Rule 71.1)

Map.	WO 800 068
Ingek.	11 OKT. 1999
Termijn	(26.11.1999)
Date of mailing (day/month/year)	27.10.99

08.10.99

Applicant's or agent's file reference  
WO 800068-A1/ho

IMPORTANT NOTIFICATION

International application No.  
PCT/NL98/00371

International filing date (day/month/year)  
26/06/1998

Priority date (day/month/year)  
26/06/1997

Applicant

BTG BIOMASS TECHNOLOGY GROUP B.V. et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices, see also 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



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# PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference WO 800068-A1/ho		<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/NL98/00371	International filing date (day/month/year) 26/06/1998	Priority date (day/month/year) 26/06/1997	
International Patent Classification (IPC) or national classification and IPC C02F11/08			
Applicant BTG BIOMASS TECHNOLOGY GROUP B.V. et al.			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 4 sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> <li>I <input checked="" type="checkbox"/> Basis of the report</li> <li>II <input type="checkbox"/> Priority</li> <li>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</li> <li>IV <input type="checkbox"/> Lack of unity of invention</li> <li>V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</li> <li>VI <input type="checkbox"/> Certain documents cited</li> <li>VII <input type="checkbox"/> Certain defects in the international application</li> <li>VIII <input checked="" type="checkbox"/> Certain observations on the international application</li> </ul>			
Date of submission of the demand  28/12/1998		Date of completion of this report  08.10.99	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized officer  Rumbo, A  Telephone No. +49 89 2399 8407	



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/NL98/00371

**I. Basis of the report**

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

**Description, pages:**

1-11 as originally filed

**Claims, No.:**

1-19 as received on 20/08/1999 with letter of 16/08/1999

**Drawings, sheets:**

1-3 as originally filed

**2. The amendments have resulted in the cancellation of:**

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

**4. Additional observations, if necessary:**

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/NL98/00371

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Yes: Claims 1-19
	No: Claims
Inventive step (IS)	Yes: Claims
	No: Claims 1-19
Industrial applicability (IA)	Yes: Claims 1-19
	No: Claims

**2. Citations and explanations**

**see separate sheet**

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

**see separate sheet**

**SECTION V (NOVELTY AND INVENTIVE STEP)**

1. The claimed subject-matter meets the requirements of Article 33(2) PCT.

The only concept linking together the wording of the independent claims, namely a gasifier and its use for producing fuel gas by heat treating in counterflow an aqueous feed containing carbon atoms is novel in view of the closest prior art documents D1=US-A- 4 113 446 (see abstract, claims 1, 6 and 7; examples 1 to 3) and D2= US-A- 4 166 802 (see abstract, claim 1 and col. 4, lines 3-27). In fact none of the cited documents discloses the counterflow treatment of the aqueous feed containing carbon atoms by heat.

2. The claimed subject-matter does not meet the requirements of Article 33(3) PCT.

The absence of at least an objectively solved technical problem as a consequence of the only differentiating technical feature present in the wording of all the independent claims (namely the counterflow heat treatment), the inventive step of the claimed subject-matter cannot be acknowledged.

In fact modifications which do not solve any technical problem can be considered as obvious for the skilled person and therefore not inventive according to Article 33(3) PCT.

At present time nowhere in the application as filed it is disclosed that a technical problem can be solved, by using a counterflow heat treatment which cannot be solved by the technical means referred to in D1 and D2.

Furthermore, the counterflow heating treatments are well known for the skilled person and its use constitutes a selection between two possibilities for heating (co-flow and counter-flow) which can be made by every skilled person without implying any inventive step.

The same comment applies for the technical features of each dependent claim.

**SECTION VIII (CLARITY)**

1. The claimed subject-matter does not meet the requirements of Article 6 PCT.

The presence of three independent claims (#1, #12 and #15) each of them containing technical features completely different from those contained in the wording of the others, does not allow third parties to know which of them are essential for the invention to be performed and which other merely constitute optional technical features.

In fact, the feature "cooling" under point iv) of claim 1 is not disclosed in claim 15.

In the same way, the features high pressure pump (line 5 of claim 12) and the feature from line 12 to line 18 (which reactor... and a second inlet for a fuel) of claim 12 are not disclosed in either claim 1 or 15.

Finally, the presence of a second reactor chamber (lines 6-7), the features of lines 10 to 17 (the first chamber... has been separated from combustible gas) as well as the feature of lines 21 to 28 (the second chamber.... has been subjected to thermal treatment an oxidation) are neither disclosed in claim 1 or claim 12.

The support for the terms "**the arrangement** of inlets and outlets providing for counterflow heat-exchange over the course of treatment" in the wording of claim 12 has not been found in the description and the claims and it has not been cited by the applicant.

In order to overcome the above objection, the applicant is requested:

first) to file only one independent claim per claim category,

second) to include **exactly the same technical features** in each independent claim,

third) to indicate the support in the description or the claims for any amendment.

Failure to do as requested, the clarity of the claimed subject-matter cannot be acknowledged.



16. 08. 1999

CLAIMS

(70)

1. A method of the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified, to yield a combustible gas, which method comprises the following steps:

5           i) feeding the aqueous fluid comprising carbonaceous material to be gasified to a reactor comprising a course of treatment;

          ii) transferring heat to the carbonaceous material-comprising aqueous fluid in counterflow;

10           iii) the gasification of the carbonaceous material in the course of treatment at an elevated temperature in the presence of water, to yield a product stream comprising combustible gas and a carbonaceous material-depleted aqueous fluid; and

15           iv) cooling the product stream until the carbonaceous material-depleted aqueous fluid at least partially comprises a carbonaceous material-depleted aqueous fluid and the separation of the combustible gas from the carbonaceous material-depleted aqueous fluid.

20           2. A method according to claim 1, characterized in that the gasification in step iii) is carried out at a temperature and pressure equal to or higher than the critical temperature and pressure of water.

25           3. A method according to claim 2, characterized in that the gasification in step iii) is carried out at a temperature higher than 400°C, preferably higher than 500°C.

30           4. A method according to one of the preceding claims, characterized in that cooling of the product stream in step iv) is carried out by feeding it in counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

35           5. A method according to one of the claims 1-3, characterized in that the carbonaceous material-depleted aqueous fluid is heated, oxygen-comprising gas is intro-

duced into the heated fluid, oxygen is reacted with the carbonaceous material present in the depleted aqueous fluid producing heat, which heat is transferred to an aqueous fluid comprising carbonaceous material to be gasified.

6. A method according to one of the preceding claims, characterized in that a portion of the combustible gas formed is used to attain the elevated temperature described in step ii).

7. A method according to one of the preceding claims, characterized in that subsequent heating is effectuated by counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

8. A method according to one of the preceding claims, characterized in that the heat supplied to the fluid comprising material to be gasified stems from an exothermal synthesis reaction.

9. A method according to claim 6 or 7, characterized in that the combustible gas is combusted in a combustion installation to yield electricity and heat.

10. A method according to one of the preceding claims, characterized in that the carbonaceous material to be gasified is biomass.

11. A method according to claim 10, characterized in that the biomass is selected from the group comprising semi-liquid manure and manure suspended in water.

12. An installation for the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified to yield a combustible gas and an aqueous fluid poor in carbonaceous material to be gasified comprising a high-pressure pump for feeding under high pressure the aqueous fluid comprising carbonaceous material to be gasified to an elongated tubular reactor having a first and a second end, wherein the first end is provided with an inlet for the aqueous fluid comprising carbonaceous material to be gasified, and the second end is provided with an outlet for a product stream comprising the combustible gas and the aqueous fluid poor in carbonaceous material, which reactor is provided in a chamber of an

incinerator, which chamber is separated from the lumen of the tubular reactor by means of a heat-conducting reactor wall defining a course of treatment, at the side of the outlet of the tubular reactor the incinerator is provided with a first inlet for oxygen-comprising gas and a second inlet for a fuel, and at the side of the inlet of the reactor the chamber is provided with an exhaust for combustion products, the arrangement of inlets and outlets providing for counterflow heat-exchange over the course of treatment and the exhaust of the reactor is connected to means for cooling the product stream and means for the separation of the combustible gas formed as a result of gasification, and carbonaceous material-depleted aqueous fluid.

13. An installation according to claim 12, characterized in that the installation comprises a heat exchanger conducting the carbonaceous material-depleted fluid coming from the tubular reactor in counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

14. An installation according to claim 12 or 13, characterized in that the installation comprises a heat exchanger for conducting combustion products coming from the incinerator in counterflow to oxygen-comprising gas to be supplied to the first inlet.

15. An installation for the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified to yield a combustible gas and a carbonaceous material-depleted aqueous fluid to be gasified, which installation comprises a gasification reactor having a substantially elongated first chamber and a substantially elongated second chamber, the first chamber comprising an inlet opening for the thermal treatment of aqueous fluid comprising carbonaceous material to be gasified, the first chamber and the second chamber being separated by a heat-conducting wall, which heat-conducting wall defines a course of treatment along which, after separation of the combustible gas, the aqueous fluid comprising carbonaceous material to be gasified is conducted in counterflow to an

aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material to be gasified and has been separated from combustible gas, the installation further comprises means for separating the combustible gas and the aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material, as well as an exhaust for the combustible gas, further the second chamber is provided with an inlet opening for the supply of compressed oxygen-comprising gas via a pipe and by means of a pumping organ to the aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material and which has separated from the combustible gas, and an outlet for a fluid which has been subjected to thermal treatment and oxidation.

16. An installation according to claim 15, characterized in that the means for separating the combustible gas and the aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material, comprise a heat exchanger.

17. An installation according to claim 15 or 16, characterized in that the installation comprises means for the combustion of the combustible gas to yield electricity and heat.

18. An installation according to claim 17, characterized in that the installation further comprises a heat-conducting surface for transferring to at least one chamber heat released during combustion.

19. An installation according to claim 18, characterized in that the first chamber surrounds in the longitudinal direction substantially the second chamber and the heat-conducting surface surrounds in the longitudinal direction substantially the first chamber.

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>WO 800068-A1</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/NL 98/ 00371</b>	International filing date (day/month/year) <b>26/06/1998</b>	(Earliest) Priority Date (day/month/year) <b>26/06/1997</b>
Applicant  <b>BTG BIOMASS TECHNOLOGY GROUP B.V. et al.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. ☐ Certain claims were found unsearchable (see Box I).
2. ☐ Unity of invention is lacking (see Box II).
3. ☐ The international application contains disclosure of a **nucleotide and/or amino acid sequence listing** and the international search was carried out on the basis of the sequence listing
  - ☐ filed with the international application.
  - ☐ furnished by the applicant separately from the international application,
    - ☐ but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
  - ☐ Transcribed by this Authority
4. With regard to the title, ☒ the text is approved as submitted by the applicant
  - ☐ the text has been established by this Authority to read as follows:
5. With regard to the abstract,
  - ☒ the text is approved as submitted by the applicant
  - ☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this International Search Report, submit comments to this Authority.
6. The figure of the **drawings** to be published with the abstract is:
  - Figure No.            ☐ as suggested by the applicant.
  - ☐ because the applicant failed to suggest a figure.
  - ☐ because this figure better characterizes the invention.
  - ☒ None of the figures.

## IN NATIONAL SEARCH REPORT

International Application No

PCT/NL 98/00371

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C02F11/08 C10J3/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C02F C10J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	EP 0 051 817 A (HOECHST) 19 May 1982 see page 5, line 10 - page 6, line 29 ---	1 5
Y	US 4 166 802 A (SLATER) 4 September 1979 see column 3, line 43 - column 4, line 62 ---	1
A	US 4 113 446 A (MODELL) 12 September 1978 see column 8-10; claims 1-10 ---	1,2
A	NL 1 000 967 C (HOMALIMA) 1 April 1997 see the whole document ---	1,11
A	GEURDEN: "SUPERKRITISCHE BEHANDELING VAN VARKENS DRIJFMEST" PROCESSTECHNIEK, vol. 4, no. 43, April 1988, pages 35-37, XP002057876 see the whole document ---	1,2,11
	--- -/--	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## ° Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

1 October 1998

Date of mailing of the international search report

12/10/1998

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel: (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Wendling, J-P

## IN NATIONAL SEARCH REPORT

ernational Application No

PCT/NL 98/00371

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 604 957 A (CEDRQUIST) 12 August 1986 see column 6-8; claims 1,2 ----	1
A	US 5 240 619 A (COPA) 31 August 1993 see column 7-8; claims 1-16 ----	1,2
A	US 3 060 118 A (SCHOEFFEL) 23 October 1962 ----	
A	EP 0 240 340 A (VERTECH TREATMENT SYSTEMS) 7 October 1987 see page 12; claim 7 -----	12,15,17

# IN NATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/NL 98/00371

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 51817	A	19-05-1982	DE 3042193 A		24-06-1982
			US 4347144 A		31-08-1982
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US 4166802	A	04-09-1979	AU 523469 B		29-07-1982
			AU 4607579 A		25-10-1979
			DE 2912833 A		08-11-1979
			IN 149686 A		13-03-1982
			JP 54139902 A		30-10-1979
<hr/>					
US 4113446	A	12-09-1978	NONE		
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NL 1000967	C	11-02-1997	NONE		
<hr/>					
US 4604957	A	12-08-1986	NONE		
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US 5240619	A	31-08-1993	CA 2095803 A		12-08-1994
			EP 0610616 A		17-08-1994
			MX 9304013 A		31-08-1994
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US 3060118	A	23-10-1962	NONE		
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EP 240340	A	07-10-1987	US 4721575 A		26-01-1988
			CA 1276776 A		27-11-1990
			DE 3781921 A		05-11-1992
			DK 173187 A		04-10-1987
			FI 871446 A,B		04-10-1987
			PT 84610 B		08-05-1989
			JP 63100927 A		06-05-1988
			NL 8602374 A		02-11-1987
			US 4869833 A		26-09-1989
<hr/>					



From the INTERNATIONAL SEARCHING AUTHORITY

**PCT**NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL SEARCH REPORT  
OR THE DECLARATION

(PCT Rule 44.1)

To:

OCTROOIBUREAU LOS EN STIGTER B.V.  
Attn. ALTENBURG, B.  
Weteringschans 96  
NL-1017 XS Amsterdam  
NETHERLANDS

WO 800060

13 OCT. 1998

12.12.1998 (21.12.1998)

Form (A)

Date of mailing  
(day/month/year)

12/10/1998

Applicant's or agent's file reference

WO 800068-A1

**FOR FURTHER ACTION**

See paragraphs 1 and 4 below

International application No.

PCT/NL 98/00371

International filing date  
(day/month/year)

26/06/1998

Applicant

BTG BIOMASS TECHNOLOGY GROUP B.V. et al.

- 1.
- ☒
- The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

**Filing of amendments and statement under Article 19**

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

**When?** The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.**Where?** Directly to the International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland  
Facsimile No.: (41-22) 740.14.35**For more detailed instructions,** see the notes on the accompanying sheet.

- 2.
- ☐
- The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

- 3.
- ☐
- With regard to the protest**
- against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

- 4.
- Further action(s):**
- The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority

European Patent Office, P.B. 5818 Patentlaan 2  
NL-2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.  
Fax: (+31-70) 340-3016

Authorized officer

Nathalie Desverchere

## NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

### INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

#### What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

#### When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

#### Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

#### How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

#### What documents must/may accompany the amendments?

##### Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

## NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:  
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:  
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:  
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added."  
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:  
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

### "Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

**It must be in the language in which the international application is to be published.**

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

### Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

### Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>WO 800068-A1</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/NL 98/ 00371</b>	International filing date (day/month/year) <b>26/06/1998</b>	(Earliest) Priority Date (day/month/year) <b>26/06/1997</b>
Applicant  <b>BTG BIOMASS TECHNOLOGY GROUP B.V. et al.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. ☐ Certain claims were found unsearchable (see Box I).

2. ☐ Unity of invention is lacking (see Box II).

3. ☐ The international application contains disclosure of a **nucleotide and/or amino acid sequence listing** and the international search was carried out on the basis of the sequence listing

☐ filed with the international application.

☐ furnished by the applicant separately from the international application,

☐ but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.

☐ Transcribed by this Authority

4. With regard to the **title**, ☒ the text is approved as submitted by the applicant

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this International Search Report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is:

Figure No. \_\_\_\_\_ ☐ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

☒ None of the figures.

## IN NATIONAL SEARCH REPORT

International Application No

PCT/NL 98/00371

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C02F11/08 C10J3/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C02F C10J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	EP 0 051 817 A (HOECHST) 19 May 1982 see page 5, line 10 - page 6, line 29 ---	1 5
Y	US 4 166 802 A (SLATER) 4 September 1979 see column 3, line 43 - column 4, line 62 ---	1
A	US 4 113 446 A (MODELL) 12 September 1978 see column 8-10; claims 1-10 ---	1,2
A	NL 1 000 967 C (HOMALIMA) 1 April 1997 see the whole document ---	1,11
A	GEURDEN: "SUPERKRITISCHE BEHANDELING VAN VARKENS DRIJFMEST" PROCESSTECHNIEK, vol. 4, no. 43, April 1988, pages 35-37, XP002057876 see the whole document ---	1,2,11
	--- -/--	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

1 October 1998

Date of mailing of the international search report

12/10/1998

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Wendling, J-P

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/NL 98/00371

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 604 957 A (CEDRQUIST) 12 August 1986 see column 6-8; claims 1,2 ---	1
A	US 5 240 619 A (COPA) 31 August 1993 see column 7-8; claims 1-16 ---	1,2
A	US 3 060 118 A (SCHOEFFEL) 23 October 1962 ---	
A	EP 0 240 340 A (VERTECH TREATMENT SYSTEMS) 7 October 1987 see page 12; claim 7 -----	12,15,17

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/NL 98/00371

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 51817	A	19-05-1982	DE 3042193 A	24-06-1982
			US 4347144 A	31-08-1982
US 4166802	A	04-09-1979	AU 523469 B	29-07-1982
			AU 4607579 A	25-10-1979
			DE 2912833 A	08-11-1979
			IN 149686 A	13-03-1982
			JP 54139902 A	30-10-1979
US 4113446	A	12-09-1978	NONE	
NL 1000967	C	11-02-1997	NONE	
US 4604957	A	12-08-1986	NONE	
US 5240619	A	31-08-1993	CA 2095803 A	12-08-1994
			EP 0610616 A	17-08-1994
			MX 9304013 A	31-08-1994
US 3060118	A	23-10-1962	NONE	
EP 240340	A	07-10-1987	US 4721575 A	26-01-1988
			CA 1276776 A	27-11-1990
			DE 3781921 A	05-11-1992
			DK 173187 A	04-10-1987
			FI 871446 A,B	04-10-1987
			PT 84610 B	08-05-1989
			JP 63100927 A	06-05-1988
			NL 8602374 A	02-11-1987
			US 4869833 A	26-09-1989

CLAIMS

5 1. A method of the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified, to yield a combustible gas, which method comprises the following steps:

10 i) feeding the aqueous fluid comprising carbonaceous material to be gasified to a reactor comprising a course of treatment;

ii) transferring heat to the carbonaceous material-comprising aqueous fluid in counterflow;

15 iii) the gasification of the carbonaceous material in the course of treatment at an elevated temperature in the presence of water, to yield a product stream comprising combustible gas and a carbonaceous material-depleted aqueous fluid; and

20 iv) cooling the product stream until the carbonaceous material-depleted aqueous fluid at least partially comprises a carbonaceous material-depleted aqueous fluid and the separation of the combustible gas from the carbonaceous material-depleted aqueous fluid.

25 2. A method according to claim 1, characterized in that the gasification in step iii) is carried out at a temperature and pressure equal to or higher than the critical temperature and pressure of water.

30 3. A method according to claim 2, characterized in that the gasification in step iii) is carried out at a temperature higher than 400°C, preferably higher than 500°C.

35 4. A method according to one of the preceding claims, characterized in that cooling of the product stream in step iv) is carried out by feeding it in counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

5. A method according to one of the claims 1-3, characterized in that the carbonaceous material-depleted aqueous fluid is heated, oxygen-comprising gas is introduced into the heated fluid, oxygen is reacted with the



carbonaceous material present in the depleted aqueous fluid producing heat, which heat is transferred to an aqueous fluid comprising carbonaceous material to be gasified.

5           6. A method according to one of the preceding claims, characterized in that a portion of the combustible gas formed is used to attain the elevated temperature described in step ii).

10           7. A method according to one of the preceding claims, characterized in that subsequent heating is effected by counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

15           8. A method according to one of the preceding claims, characterized in that the heat supplied to the fluid comprising material to be gasified stems from an exothermal synthesis reaction.

9. A method according to claim 6 or 7, characterized in that the combustible gas is combusted in a combustion installation to yield electricity and heat.

20           10. A method according to one of the preceding claims, characterized in that the carbonaceous material to be gasified is biomass.

25           11. A method according to claim 10, characterized in that the biomass is selected from the group comprising semi-liquid manure and manure suspended in water.

30           12. An installation for the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified to yield a combustible gas and an aqueous fluid poor in carbonaceous material to be gasified comprising a high-pressure pump for feeding under high pressure the aqueous fluid comprising carbonaceous material to be gasified to an elongated tubular reactor having a first and a second end, wherein the first end is provided with an inlet for the aqueous fluid comprising carbonaceous material to be gasified, and the second end is provided with an outlet for the carbonaceous material-depleted aqueous fluid, which reactor is provided in a chamber of an incinerator, which chamber is separated from the lumen of the tubular reactor by means of a heat-conducting reactor

35

5 wall defining a course of treatment at the side of the outlet of the tubular reactor the incinerator is provided with a first inlet for oxygen-comprising gas and a second inlet for a fuel, and at the side of the inlet of the reactor the chamber is provided with an exhaust for combustion products, and the exhaust of the reactor is connected to means for the separation of combustible gas formed as a result of gasification, and carbonaceous - material-depleted aqueous fluid.

10 13. An installation according to claim 12, characterized in that the installation comprises a heat exchanger conducting the carbonaceous material-depleted fluid coming from the tubular reactor in counterflow to the aqueous fluid comprising carbonaceous material to be gasified.

15 14. An installation according to claim 12 or 13, characterized in that the installation comprises a heat exchanger for conducting combustion products coming from the incinerator in counterflow to oxygen-comprising gas to be supplied to the first inlet.

20 15. An installation for the thermal treatment of an aqueous fluid comprising carbonaceous material to be gasified to yield a combustible gas and a carbonaceous material-depleted aqueous fluid to be gasified, which installation comprises a gasification reactor having a substantially elongated first chamber and a substantially elongated second chamber, the first chamber comprising an inlet opening for the thermal treatment of aqueous fluid comprising carbonaceous material to be gasified, the first chamber and the second chamber being separated by a heat-conducting wall, which heat-conducting wall defines a course of treatment along which, after separation of the combustible gas, the aqueous fluid comprising carbonaceous material to be gasified is conducted in counterflow to an aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material to be gasified and has been separated from combustible gas, the installation further comprises means for separating the combustible gas and the aqueous fluid which, as a result of thermal treat-

ment, has become poor in carbonaceous material, as well as an exhaust for the combustible gas, further the second chamber is provided with an inlet opening for the supply of compressed oxygen-comprising gas via a pipe and by means of a pumping organ to the aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material and which has separated from the combustible gas, and an outlet for a fluid which has been subjected to thermal treatment and oxidation.

10           16. An installation according to claim 15, characterized in that the means for separating the combustible gas and the aqueous fluid which, as a result of thermal treatment, has become poor in carbonaceous material, comprise a heat exchanger.

15           17. An installation according to claim 15 or 16, characterized in that the installation comprises means for the combustion of the combustible gas to yield electricity and heat.

20           18. An installation according to claim 17, characterized in that the installation further comprises a heat-conducting surface for transferring to at least one chamber heat released during combustion.

25           19. An installation according to claim 18, characterized in that the first chamber surrounds in the longitudinal direction substantially the second chamber and the heat-conducting surface surrounds in the longitudinal direction substantially the first chamber.

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

RECORD COPY

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PCT/NL 98 / 00371  
International Application No.

26 JUN 1998  
International Filing Date

(26.06.98)

BUREAU VOOR DE INDUSTRIËLE EIGENDOM  
P.C.T. INTERNATIONAL APPLICATION

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference  
(if desired) (12 characters maximum) WO 800068-A1

Box No. I TITLE OF INVENTION Method of thermically treating a carbon-  
aceous material-comprising aqueous fluid and an apparatus  
therefor

Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation.  
The address must include postal code and name of country. The country of the address indicated in this  
Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

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State (i.e. country) of nationality:

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This person is applicant  
for the purposes of:

☐ all designated  
States

☒ all designated States except  
the United States of America

☐ the United States  
of America only

☐ the States indicated in  
the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation.  
The address must include postal code and name of country. The country of the address indicated in this  
Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

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☐ applicant and inventor

☐ inventor only (if this check-box  
is marked, do not fill in below.)

State (i.e. country) of nationality:

NL

State (i.e. country) of residence:

NL

This person is applicant  
for the purposes of:

☐ all designated  
States

☒ all designated States except  
the United States of America

☐ the United States  
of America only

☐ the States indicated in  
the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf  
of the applicant(s) before the competent International Authorities as:

☒ agent

☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation.  
The address must include postal code and name of country.)

Altenburg, Bernardus Stephanus Franciscus et al.  
OCTROOIBUREAU LOS EN STIGTER B.V.  
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Teleprinter No.

☐ Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to  
indicate a special address to which correspondence should be sent.

## Continuation of Box No. III FURTHER APPLICANTS AND/OR (FURTHER) INVENTORS

*If none of the following sub-boxes is used, this sheet is not to be included in the request.*

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

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This person is:

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☒ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

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State (i.e. country) of residence:

NL

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

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- ☐ applicant only  
☒ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

NL

State (i.e. country) of residence:

NL

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only  
☐ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

State (i.e. country) of residence:

This person is applicant for the purposes of:

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Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (i.e. country) of residence if no State of residence is indicated below.)

This person is:

- ☐ applicant only  
☐ applicant and inventor  
☐ inventor only (If this check-box is marked, do not fill in below.)

State (i.e. country) of nationality:

State (i.e. country) of residence:

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

## B x N . V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

## Regional Patent

- ☐ AP **ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SZ Swaziland, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☐ EA **Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ EP **European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☐ OA **OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)

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| <input type="checkbox"/> BB Barbados                              |   |
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| <input type="checkbox"/> KP Democratic People's Republic of Korea | <input type="checkbox"/> YU Yugoslavia                                |
|   | <input type="checkbox"/> ZW Zimbabwe                                  |
| <input type="checkbox"/> KR Republic of Korea                     |   |
| <input type="checkbox"/> KZ Kazakhstan                            |   |
| <input type="checkbox"/> LC Saint Lucia                           |   |
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In addition to the designations made above, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except the designation(s) of \_\_\_\_\_  
 The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)

**Box No. VI PRIORITY CLAIM**Further priority claims are indicated in the Supplemental Box ☐

The priority of the following earlier application(s) is hereby claimed:

Country (in which, or for which, the application was filed)	Filing Date (day/month/year)	Application No.	Office of filing (only for regional or international application)
item (1) NL	26.06.1997 (June 26, 1997)	1006404	
item (2)			
item (3)			

Mark the following check-box if the certified copy of the earlier application is to be issued by the Office which for the purposes of the present international application is the receiving Office (a fee may be required):

☒ The receiving Office is hereby requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):

1

**Box No. VII INTERNATIONAL SEARCHING AUTHORITY**

Choice of International Searching Authority (ISA) (If two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):

ISA /

Earlier search Fill in where a search (international, international-type or other) by the International Searching Authority has already been carried out or requested and the Authority is now requested to base the international search, to the extent possible, on the results of that earlier search. Identify such search or request either by reference to the relevant application (or the translation thereof) or by reference to the search request:

Country (or regional Office):

Date (day/month/year):

Number:

**Box No. VIII CHECK LIST**

This international application contains the following number of sheets:

1. request : 4 sheets  
 2. description : 11 sheets  
 3. claims : 4 sheets  
 4. abstract : 1 sheets  
 5. drawings : 3 sheets

Total : 23 sheets

This international application is accompanied by the item(s) marked below:

1. ☒ separate signed power of attorney  
 2. ☐ copy of general power of attorney  
 3. ☐ statement explaining lack of signature  
 4. ☐ priority document(s) identified in Box No. VI as item(s):  
 5. ☒ fee calculation sheet  
 6. ☐ separate indications concerning deposited microorganisms  
 7. ☐ nucleotide and/or amino acid sequence listing (diskette)  
 8. ☒ other (specify) (English translation follows)  
 Copy of Search Report

Figure No. \_\_\_\_\_ of the drawings (if any) should accompany the abstract when it is published.

**Box No. IX SIGNATURE OF APPLICANT OR AGENT**

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Amsterdam, 24 June 1998



Altenburg, Bernardus Stephanus Franciscus et al.

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1. Date of actual receipt of the purported international application:	26 JUN 1998	2. Drawings: <input checked="" type="checkbox"/> received: <input type="checkbox"/> not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:		
4. Date of timely receipt of the required corrections under PCT Article 11(2):		
5. International Searching Authority specified by the applicant: ISA /	6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid	

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Date of receipt of the record copy by the International Bureau:

24 JULY 1998

(24.07.98)

Werkwijze voor het thermisch behandelen van een koolstofhoudend materiaal bevattende, waterige oplossing en inrichting daarvoor

De onderhavige uitvinding heeft betrekking op een werkwijze voor het thermisch behandelen van een te vergassen koolstofhoudend materiaalbevattende, waterige fluidum, onder oplevering van een brandbaar gas.

5           Het is in het vak reeds geruime tijd bekend om koolstofhoudend materiaal, zoals steenkool, in aanwezigheid van stoom en ondermaat zuurstof bij verhoogde temperatuur en druk te vergassen. Hierbij wordt een suspensie van kolen in water door verbranding van een deel van de steenkool sterk  
10           verhit. Hierdoor ontstaat bij een temperatuur van 1000 - 1200°C en een druk van circa 50 - 100 atmosfeer een koolmonoxide- en waterstofhoudend brandbaar gas.

          De onderhavige uitvinding heeft tot doel de bekende werkwijze te verbeteren, en in het bijzonder de energie-efficiency ervan. Daarenboven heeft de werkwijze volgens de uit-  
15           vinding tot doel de controle over de thermische behandeling te verbeteren.

          De werkwijze volgens de uitvinding omvat de stappen van:

- 20           i) het aan een reactor met een behandelingstraject toevoeren van het te vergassen koolstofhoudend materiaalbevattende waterige fluidum;
- ii) het in tegenstroom overdragen van warmte aan het koolstofhoudende materiaal bevattende waterige fluidum;
- 25           iii) het bij verhoogde temperatuur in aanwezigheid van water in het behandelingstraject vergassen van het koolstofhoudende materiaal onder oplevering van een productstroom welke brandbaar gas en een aan koolstofhoudend materiaal verarmd waterig fluidum omvat; en
- 30           iv) het afkoelen van de productstroom tot het aan koolstofhoudend materiaal verarmde waterige fluidum ten minste gedeeltelijk een aan koolstofhoudend materiaal verarmde waterige vloeistof omvat en het scheiden van het brandbare



gas en de aan koolstofhoudend materiaal verarmde waterige vloeistof.

5 Aldus wordt een hoge omzetting van (een continue stroom) te vergassen koolstofhoudend materiaal in brandbaar gas verzekerd, terwijl het brandbare gas tevens van zeer hoge kwaliteit is met een hoog gehalte aan waterstof en een laag gehalte aan CO. Stap iii) geschiedt onder zuurstofarme of -loze condities. Meer in het bijzonder wordt geen zuurstof toegevoegd.

10 Volgens een voorkeursuitvoeringsvorm geschiedt het vergassen in stap ii) bij een temperatuur en druk gelijk aan of groter dan de kritische temperatuur en druk van water.

15 Bij kritische omstandigheden is er volledige menging tussen gevormd brandbaar gas en water, waardoor een goede warmteoverdracht aan nog te vergassen koolstofhoudend materiaal verzekerd is.

Bij voorkeur geschiedt het vergassen in stap iii) bij een temperatuur van meer dan 400°C, in het bijzonder bij een temperatuur van meer dan 500°C.

20 Aldus wordt een althans nagenoeg volledige omzetting van al het oorspronkelijk aanwezige koolstofhoudende materiaal verzekerd.

25 Volgens een verdere voorkeursuitvoeringsvorm geschiedt het afkoelen van de productstroom in stap iv) door het in tegenstroom voeren met het te vergassen koolstofhoudend materiaal bevattende waterige fluïdum.

Aldus kan op energiezuinige wijze de aan koolstofhoudend materiaal verarmde vloeistof in temperatuur worden verhoogd.

30 Volgens een interessante uitvoeringsvorm wordt de aan koolstofhoudend materiaal verarmde waterige vloeistof opgewarmd, zuurstofomvattend gas in de opgewarmde vloeistof gebracht, zuurstof met de in de verarmde waterige vloeistof aanwezig koolstofhoudend materiaal reageert onder oplevering van warmte, welke warmte wordt afgestaan aan een te vergassen koolstofhoudend materiaal bevattend waterig fluïdum.

35 Volgens deze uitvoeringsvorm uitvinding wordt na afscheiding van brandbaar gas zuurstof aan de aan koolstofhoudend materiaal verarmde vloeistof toegevoerd. Nog in de

vloeistof aanwezig koolstofhoudend materiaal wordt hierdoor verbrand, onder oplevering van warmte die wordt gebruikt om het vergassingsproces gaande te houden. De warmte komt daarbij vrij op een plaats waar de warmte efficiënt kan worden overgedragen. Door de verarmde vloeistof op te warmen alvorens zuurstof toe te voeren, kan doelmatige een zeer hoge temperatuur worden bereikt. Hierbij is sprake van een zelfsturend karakter. Bijvoorbeeld, indien in eerste aanleg te weinig koolstofhoudend materiaal wordt vergast, blijft er meer koolstofhoudend materiaal over voor oxidatie en zal de temperatuurverhoging die daar het gevolg van is de vergassing bevorderen. Omgekeerd, indien teveel koolstofhoudend materiaal wordt vergast, blijft minder koolstofhoudend materiaal over voor oxidatie, en worden temperatuurexcursies voorkomen. Indien de verarmde vloeistof tot boven de kritische temperatuur en druk wordt verhit, kan de zuurstof op eenvoudige wijze volledig homogeen met de verarmde vloeistof worden gemengd.

Volgens een voorkeursuitvoeringsvorm wordt het brandbare gas in een verbrandingsinrichting verbrand onder oplevering van elektriciteit en warmte.

Aldus wordt de energie-inhoud van het te vergassen koolstofhoudende materiaal, dat een afvalstof kan zijn, benut.

Volgens een zeer gunstige uitvoeringsvorm wordt een deel van het gevormde brandbare gas gebruikt voor het bereiken van de in stap ii) beschreven verhoogde temperatuur.

Deze brandstof is ter plekke beschikbaar.

In het bijzonder geschiedt het verder verhitten in tegenstroom met het te vergassen koolstofhoudende materiaal bevattende waterige fluidum.

Aldus wordt een doelmatige energiebenutting bewerkstelligd.

Met de werkwijze volgens de uitvinding kan een verscheidenheid aan koolstofhoudende materialen worden vergast, zoals in water gesuspendeerde versnipperde biomassa, steenkool, of turf. Een interessante toepassing betreft het vergassen van drijfmest en in water gesuspendeerde mest.

Het met de werkwijze volgens de uitvinding behan-  
len van drijfmest of mest betekent enerzijds het benutten van  
de energie-inhoud ervan, en anderzijds worden problemen op  
het gebied van mestopslag, milieuverontreiniging en ziekte-  
5 verspreiding opgelost.

De uitvinding heeft tevens betrekking op een in-  
richting voor het toepassen van de werkwijze volgens de uit-  
vinding.

Een eerste inrichting voor het thermisch behandelen  
10 van een te vergassen koolstofhoudend materiaalbevattend  
waterig fluïdum onder oplevering van een brandbaar gas en een  
aan te vergassen koolstofhoudend materiaal verarmd fluïdum,  
omvat een hogedruk pomp voor het onder hoge druk voeren van  
het te vergassen koolstofhoudend materiaalbevattende fluïdum  
15 naar een langwerpige buisvormige reactor met een eerste en  
een tweede uiteinde, waarbij het eerste uiteinde is voorzien  
van een inlaat voor het te vergassen koolstofhoudend materi-  
aal bevattend waterig fluïdum, en het tweede uiteinde van een  
uitlaat voor het aan koolstofhoudend materiaal verarmde  
20 fluïdum, welke reactor is aangebracht in een kamer van een  
oven welke kamer van het lumen van de buisvormige reactor  
wordt gescheiden door een warmtegeleidende reactorwand welke  
een behandelingstraject definieert, de oven aan de zijde van  
de uitlaat van de buisvormige reactor is voorzien van een  
25 eerste inlaat voor zuurstofomvattend gas en een tweede inlaat  
voor een brandstof en de kamer aan de zijde van de inlaat van  
de reactor is voorzien van een uitlaat voor verbrandingspro-  
ducten, en de uitlaat van de reactor is aangesloten op midde-  
len voor het scheiden van door vergassing ontstaan brandbaar  
30 gas en aan koolstofhoudend materiaal verarmd waterig fluïdum.

Hiermee kan de in de verbrandingsproducten aanwezige  
warmte-energie op verscheidene manieren doelmatig worden  
gebruikt. De hete verbrandingsproducten kunnen worden ge-  
bruikt voor het maken van stoom, en desgewenst elektriciteit.  
35 De oven kan ook onder druk, bijvoorbeeld 20 bar, worden  
gestookt. De verbrandingsproducten kunnen dan middels een  
turbine worden gebruikt voor het opwekken van elektriciteit.  
In een dergelijk geval wordt de oven bij voorkeur gestookt  
met het bij de werkwijze gevormd gas onder hoge druk. De oven

kan een wervelbed oven zijn, met bijvoorbeeld aluminiumoxide als bedmateriaal. Aldus wordt de warmte-overdracht naar de reactorwand bevorderd. De brandstof kan zowel gasvormig, vloeibaar als vast zijn. Het bedmateriaal kan een katalytische activiteit bezitten, bijvoorbeeld voor het laaghouden van stikstofdioxide-emissies. Ook kan de oven zelf een reactor zijn waarin bij hoge temperatuur een exotherme omzetting plaatsvindt onder oplevering van een gewenst product. Hierbij kan bijvoorbeeld worden gedacht aan de bereiding van etheen of synthesesgas door de partiële oxidatie van methaan. Het gevormde gas wordt op opzichzelf bekende wijze opgewerkt. Als bron voor methaan kan met de werkwijze volgens de uitvinding verkregen opgewerkt brandbaar gas worden gebruikt.

Volgens een voorkeursuitvoering omvat de inrichting een warmtewisselaar voor het in tegenstroom voeren van uit de buisvormige reactor afkomstig aan te vergassen koolstofhoudend materiaal verarmd fluïdum en het te vergassen koolstofhoudend materiaal bevattende de waterige fluïdum.

Met een dergelijke inrichting kan koolstofhoudend materiaal op energetisch zeer doelmatige wijze worden vergast.

Volgens een verdere gunstige uitvoeringsvorm omvat de inrichting een warmtewisselaar voor het in tegenstroom voeren van via de uitlaat van de oven afkomstige verbrandingsproducten en na de eerste inlaat te voeren zuurstof omvattend gas.

Aldus kunnen in de reactor zeer hoge temperaturen worden bereikt en een althans nagenoeg volledige omzetting van koolstofhoudend materiaal tot gas worden verzekerd. Verder kunnen de zeer hete verbrandingsgassen die de uitlaat van de oven verlaten worden gebruikt voor het maken van stoom, bijvoorbeeld voor het opwekken van elektriciteit.

Een alternatieve inrichting voor het thermisch behandelen van een te vergassen koolstofhoudend materiaalbevattende waterige vloeistof onder oplevering van een brandbaar gas en een aan te vergassen koolstofhoudend materiaalbevattende verarmde vloeistof, volgens de onderhavige uitvinding omvat een vergassingsreactor met een in hoofdzaak langwerpige eerste kamer en een in hoofdzaak langwerpige tweede

kamer, de eerste kamer een toevoeropening voor de thermisch te behandelen te vergassen koolstofhoudend materiaalbevattende waterige vloeistof omvat, de eerste kamer en de tweede kamer van elkaar worden gescheiden door een warmtegeleidende wand, welke warmtegeleidende wand een behandeltraject definieert waarlangs de te vergassen koolstofhoudend materiaalbevattende waterige vloeistof en een door thermische behandeling aan te vergassen koolstofhoudend materiaal verarmde vloeistof na afscheiding van het brandbare gas in tegenstroom kunnen worden gevoerd, de inrichting verder middelen voor het scheiden van het brandbare gas en de door thermische behandeling aan koolstofhoudend materiaal verarmde vloeistof alsmede een afvoer voor het brandbare gas omvat, de tweede kamer verder is voorzien van een inlaatopening voor het via een leiding en door middel van een pomporgaan onder verhoogde druk toevoeren van zuurstofomvattend gas aan de van het brandbare gas afgescheiden, door thermisch behandeling aan koolstofhoudend materiaal verarmde vloeistof, en een uitlaatopening voor een aan een thermische behandeling en een oxidatie onderworpen vloeistof.

Een dergelijke inrichting maakt een energetisch efficiënte, zelfsturende thermische behandeling van te vergassen koolstofhoudend materiaalbevattende vloeistof mogelijk.

Volgens een gunstige uitvoeringsvorm omvatten de middelen voor het scheiden van het brandbare gas en de door thermische behandeling aan koolstofhoudend materiaal verarmde vloeistof een warmtewisselaar.

Aldus kan het brandbare gas met verhoogde efficiëntie van de aan koolstofhoudend materiaal verarmde vloeistof worden afgescheiden.

Bij voorkeur omvat de inrichting volgens de uitvinding middelen voor het verbranden van het brandbare gas onder oplevering van elektriciteit en warmte.

Aldus kan, bijvoorbeeld uit een uit milieu-oogpunt lastig op te ruimen afvalstof zoals mest maar ook GFT, actief slib, bermgras enz., hoogwaardige energie worden verkregen.

Volgens een verdere gunstige uitvoeringsvorm van de inrichting volgens de uitvinding, omvat de inrichting verder

een warmtegeleidend oppervlak voor het aan ten minste één kamer overdragen van bij de verbranding vrijgekomen warmte.

Volgens een voorkeursuitvoeringsvorm omgeeft de eerste kamer in de lengterichting de tweede kamer in hoofd-  
5 zaak en omgeeft het warmtegeleidende oppervlak in de lengterichting de eerste kamer in hoofdzaak.

Dergelijke inrichtingen zijn energetisch efficiënter.

De uitvinding zal thans worden toegelicht aan de  
10 hand van de volgende figuurbeschrijving en onder verwijzing naar de bijgaande tekening, waarbij

fig. 1 een schematische weergave is van een eerste inrichting geschikt voor het uitvoeren van de werkwijze volgens de uitvinding is;

15 fig. 2 een deel van een tweede inrichting geschikt voor het uitvoeren van de werkwijze volgens de uitvinding schematisch weergeeft; en

fig. 3 een schematische weergave voorstelt van een derde inrichting geschikt voor het toepassen van de werkwijze  
20 volgens de uitvinding.

Thans wordt verwezen naar fig. 1, waarin een reactor 1 is weergegeven met een inlaat 2 voor een thermisch te behandelen koolstofhoudend materiaalbevattende waterige vloeistof. Deze vloeistof kan worden bereid in een vat 3  
25 waarin water ( $H_2O$ ) wordt gebracht alsmede een koolstofhoudend materiaal C. Dit koolstofhoudende materiaal kan versnipperde biomassa, kolen, mest enz. zijn. Een oplossing of suspensie van het koolstofhoudende materiaal in water wordt door middel van een pomp 4 via de inlaat 2 als de thermische te behan-  
30 len, koolstofhoudend materiaalbevattende waterige vloeistof in de reactor gebracht. De inlaat 2 mondt uit in een langwerpige eerste kamer 5 welke door een warmtegeleidende wand 6 is afgescheiden van een tweede kamer 7. Althans een deel van het koolstofhoudende materiaal wordt in de eerste kamer 5 vergast  
35 onder oplevering van een mengsel van brandbaar gas en een aan koolstofhoudend materiaal verarmde vloeistof. Dit mengsel verlaat, in de hier weergegeven uitvoeringsvorm, de reactor 1 via uitlaat 8 en komt terecht in een warmtewisselaar 9, waarin het mengsel wordt afgekoeld. Dit afkoelen bevordert de

scheiding tussen brandbaar gas en aan koolstofhoudend materiaal verarmde vloeistof. In vat 10 wordt de verarmde vloeistof gescheiden van het brandbare gas. Dit brandbare gas kan via een leiding 11 naar een inrichting 12 worden gevoerd, welke inrichting 12 geschikt is voor het opwekken van elektriciteit. De inrichting 12 kan een turbine omvatten, een verbrandingsmotor of, in combinatie met een reformer voor het verhogen van het waterstofgehalte in het gas, een brandstofcel.

De aan koolstofhoudend materiaal verarmde vloeistof uit vat 10 kan via de warmtewisselaar 9 worden opgewarmd en met behulp van pomp 13 onder verhoogde druk in de tweede kamer 7 worden gebracht.

Een zuurstofhoudend gas, zoals bij voorkeur lucht, wordt via een pomp 14 en inlaat 15 in de tweede kamer 7 gebracht. De zuurstof reageert met nog in de verarmde vloeistof aanwezig koolstofhoudend materiaal onder oplevering van warmte. Deze warmte wordt via de warmtegeleidende wand 6 aan de te vergassen koolstofhoudend materiaalbevattende waterige vloeistof overgedragen. Bij voorkeur heersen in de tweede kamer nabij de inlaat 15 superkritische omstandigheden, waardoor de menging van zuurstof met aan koolstofhoudend materiaal verarmde vloeistof op eenvoudige wijze homogeen geschiedt.

Het verschaffen van de voor vergassing benodigde energie door oxidatie van overgebleven koolstofhoudend materiaal levert een in hoge mate zelfgecontroleerd thermisch behandelingsproces op.

De aan een oxidatie door zuurstof onderworpen en daardoor in wezen geen (oxideerbaar) koolstofhoudend materiaal meer bevattende vloeistof beweegt in tegenstroom met de te vergassen koolstofhoudend materiaalbevattende waterige vloeistof, en staat aldus efficiënt warmte af. De afgekoelde, in wezen koolstofhoudend materiaalvrije vloeistof verlaat de reactor 1 via uitlaat 16 en komt, in de weergegeven uitvoeringsvorm, in een vat 17 waar schoon water 18, dat kan worden afgevoerd of worden gebruikt voor het bereiden van een koolstofhoudend materiaalbevattende waterige vloeistof, en inerte gassen, zoals bij de oxidatie gevormd kooldioxide en eventueel stikstofgas, worden gescheiden.

Met voordeel bevat de thermisch te behandelen koolstofhoudend materiaalbevattende waterige vloeistof een katalysator die de vorming van brandbaar gas bevordert. Deze katalysator kan de vorm hebben van een ion of een edelmetaaldeeltje, dat, indien het schone water uit vat 17 weer wordt gebruikt voor het bereiden van suspensie, in een of meer malen in kringloop kan worden gehouden, totdat het schone water teveel uit koolstofhoudend uitgangsmateriaal afkomstige anorganische zouten bevat en geheel of gedeeltelijk moet worden afgevoerd of opgewerkt.

Desgewenst omvat de inrichting volgens de uitvinding ook middelen (niet weergegeven) voor het benutten van de drukenergie. Deze kan hetzij worden benut voor het opwekken van elektriciteit, hetzij voor het vergemakkelijken van de terugvoer van aan koolstofhoudend materiaal verarmde vloeistof in de reactor 1, in het bijzonder in tweede kamer 7 daarvan. Zo kan voor het terugvoeren in de tweede kamer 7 bijvoorbeeld drukenergie van het gas dat het vat 10 verlaat worden gebruikt. Ook de drukenergie van de vloeistof die het vat 17 verlaat kan worden benut voor het verlichten van de arbeid van pomp 4 of voor het opwekken van elektriciteit.

Een alternatieve uitvoeringsvorm van een inrichting volgens de uitvinding geschikt voor de werkwijze volgens de uitvinding is schematisch weergegeven in fig. 2. Het hiervoor beschreven mengsel dat de uitlaat 8 verlaat wordt in warmtewisselaar 9 afgekoeld. De hierbij vrijkomende warmte-energie wordt benut voor het opwarmen van thermisch te behandelen koolstofhoudend materiaalbevattende waterige vloeistof in warmtewisselaar 9'. Warmtewisselaar 9 en 9' zijn met voordeel dezelfde warmtewisselaar. Het afgekoelde mengsel, dat een hoge druk bezit, kan worden geëxpandeerd over een turbine 19, waardoor elektrische energie kan worden opgewekt. Het gas kan vervolgens, onder toevoer van een zuurstofomvattend gas, gebruikelijk lucht, worden verbrand. Dit kan in een tweede turbine 20 geschieden, onder oplevering van warmte en elektriciteit. De nog hete verbrandingsgassen uit de turbine 20 worden, in de weergegeven uitvoeringsvorm, benut voor het in tegenstroom verhitten, in een warmtewisselaar 21, van aan



koolstof verarmde vloeistof uit vat 10. Deze vloeistof wordt met behulp van een pomp 22 in de tweede kamer 7 gebracht. Tussen het vat 10 en de turbine 19 kan een warmtewisselaar 23 zijn geplaatst voor het opwarmen van uit het vat 10 afkomstig brandbaar gas, waardoor de druk en daarmee het rendement over turbine 19 verder kan worden verhoogd. De benodigde warmte is met voordeel afkomstig van de stroom die via warmtewisselaar 23', die met voordeel dezelfde is als warmtewisselaar 23, de tweede kamer 7 verlaat.

De verbrandingsgassen kunnen, binnen het kader van de onderhavige uitvinding, ook worden toegevoerd aan een verdere inrichting voor het thermisch behandelen van een vloeistof, zoals een te vergassen koolstofhoudend materiaal-bevattende vloeistof, welke inrichting beschikt over een de warmte geleidende scheidingswand tussen een eerste kamer en een tweede kamer, alsmede een warmtegeleidend oppervlak voor het overdragen van warmte van verbrandingsgas op koudere vloeistof.

Volgens een belangrijke alternatieve uitvoeringsvorm van de werkwijze volgens de uitvinding wordt afgezien van het toevoeren van zuurstof wanneer de vergassing bij een temperatuur en onder een druk wordt uitgevoerd die ruim boven de kritische temperatuur en druk van water liggen. Hierbij kan gebruik worden gemaakt van een in fig. 3 weergegeven inrichting met een capaciteit van 100 MW betrokken op de energie-inhoud van het koolstofhoudende materiaal. De inrichting omvat een hogedruk pomp 24, waarmee een slurrie A van verkleinde biomassa, zoals houtzaagsel, met een vaste-stof gehalte van 20% onder een druk van 30 MPa via een warmtewisselaar 25, en een inlaat 26 in een buisvormige reactor 27 wordt gevoerd. De buisvormige reactor 27 is geschikt vervaardigd uit Incoloy 625 en heeft bijvoorbeeld een (totale) lengte van 725 m en oppervlak van 114 m<sup>2</sup>. De aan koolstofhoudend materiaal verarmde stroom die de reactor 27 via uitlaat 28 verlaat wordt in tegenstroom met de slurrie A door de warmtewisselaar 25 gevoerd en desgewenst nog verder gekoeld, bijvoorbeeld onder gebruikmaking van koelwater in warmtewisselaar 29 tot een temperatuur van 25°C. Het in de reactor 27 gevormde brandbare gas wordt in gas/vloeistofscheider 30 van

de aan koolstofhoudend materiaal verarmde stroom gescheiden. Door de druk boven deze verarmde stroom te verlagen, bijvoorbeeld tot atmosferische druk, kan uit de verarmde stroom meer gas worden gewonnen dat bijvoorbeeld voor het verder verwarmen van de te vergassen slurrie A kan worden gebruikt. Door de heersende hoge druk kan met voordeel een membraan worden gebruikt om waterstof uit de stroom af te scheiden. De resterende gasstroom kan via een inlaat 31 in een oven 32, met een hoogte van 10 - 15 m, waarin de reactor 27 is aangebracht worden gevoerd. Oven 32 omvat tevens een inlaat 33 voor een zuurstofomvattende brandstof zoals lucht. Zoals te zien in fig. 3 wordt de te vergassen slurrie A in tegenstroom met bij de verbranding vrijgekomen hete gassen gevoerd. In de weergegeven uitvoeringsvorm verlaten de hete gassen de oven 32 via een uitlaat 34 en wordt de energie-inhoud ervan benut voor het opwarmen van via inlaat 33 aan de oven 32 toe te voeren lucht door het in tegenstroom voeren van de hete gassen met de lucht in warmtewisselaar 35. Een geschikte inrichting heeft bijvoorbeeld een warmtewisselaar 25 met een oppervlak van 888 m<sup>2</sup> en een warmte-overdrachtscoëfficiënt van 1200W/m<sup>2</sup>.K en wordt gevoed met een debiet van 32 kg droge stof (in 128 kg water) per seconde. Door af te zien van het gebruik van zuurstofhoudende lucht wordt tevens bereikt dat het resulterende brandbare gas slechts een laag gehalte stikstof bevat. Het gas bezit dan ook, mede daardoor, een hoge calorische waarde en kan dan ook meer algemeen worden toegepast. De temperatuur die nodig is om het gebruikte koolstofhoudend materiaal te vergassen kan door een deskundige eenvoudig worden bepaald.

Bij de hierboven beschreven inrichting is het vastestofgehalte geschikt ten minste 10% en bij voorkeur ten minste 20%, zoals ten minste 30%.

CONCLUSIES

1. Werkwijze voor het thermisch behandelen van een te vergassen koolstofhoudend materiaalbevattend, waterig fluïdum, onder oplevering van een brandbaar gas, welke werkwijze de stappen omvat van:

5 i) het aan een reactor met een behandelingstraject toevoeren van het te vergassen koolstofhoudend materiaalbevattende waterige fluïdum;

ii) het in tegenstroom overdragen van warmte aan het koolstofhoudende materiaal bevattende waterige fluïdum;

10 iii) het bij verhoogde temperatuur in aanwezigheid van water in het behandelingstraject vergassen van het koolstofhoudende materiaal onder oplevering van een productstroom welke brandbaar gas en een aan koolstofhoudend materiaal verarmd waterig fluïdum omvat; en

15 iv) het afkoelen van de productstroom tot het aan koolstofhoudend materiaal verarmde waterige fluïdum ten minste gedeeltelijk een aan koolstofhoudend materiaal verarmde waterige vloeistof omvat en het scheiden van het brandbare gas en de aan koolstofhoudend materiaal verarmde waterige vloeistof.

20 2. Werkwijze volgens conclusie 1, met het kenmerk, dat het vergassen in stap iii) geschiedt bij een temperatuur en druk gelijk aan of groter dan de kritische temperatuur en druk van water.

25 3. Werkwijze volgens conclusie 2, met het kenmerk, dat het vergassen in stap iii) geschiedt bij een temperatuur van meer dan 400°C, bij voorkeur meer dan 500°C.

30 4. Werkwijze volgens één der voorgaande conclusies, met het kenmerk, dat het afkoelen van de productstroom in stap iv) geschiedt door het in tegenstroom voeren met het te vergassen koolstofhoudend materiaal bevattende waterige fluïdum.

35 5. Werkwijze volgens één der conclusies 1 - 3, met het kenmerk, dat de aan koolstofhoudend materiaal verarmde waterige vloeistof wordt opgewarmd, zuurstofomvattend gas in de opgewarmde vloeistof wordt gebracht, zuurstof met de in de

verarmde waterige vloeistof aanwezig koolstofhoudend materiaal reageert onder oplevering van warmte, welke warmte wordt afgestaan aan een te vergassen koolstofhoudend materiaal bevattend waterig fluïdum.

5           6. Werkwijze volgens één der voorgaande conclusies, met het kenmerk, dat een deel van het gevormde brandbare gas wordt gebruikt voor het bereiken van de in stap ii) beschreven verhoogde temperatuur.

10           7. Werkwijze volgens één der voorgaande conclusies, met het kenmerk, dat het verder verhitten in tegenstroom met het te vergassen koolstofhoudende materiaal bevattende waterige fluïdum geschiedt.

15           8. Werkwijze volgens één der voorgaande conclusies, met het kenmerk, dat warmte aan het te vergassen materiaalbevattende fluïdum wordt toegevoerd afkomstig van een exotherme synthesesereactie.

            9. Werkwijze volgens conclusie 6 of 7, met het kenmerk, dat het brandbare gas in een verbrandingsinrichting wordt verbrand onder oplevering van elektriciteit en warmte.

20           10. Werkwijze volgens één der voorgaande conclusies, met het kenmerk, dat als het te vergassen koolstofhoudend materiaal biomassa wordt toegepast.

25           11. Werkwijze volgens conclusie 10, met het kenmerk, dat de biomassa wordt gekozen uit de groep van drijfmest en in water gesuspenderde mest.

30           12. Inrichting voor het thermisch behandelen van een te vergassen koolstofhoudend materiaalbevattend waterig fluïdum onder oplevering van een brandbaar gas en een aan te vergassen koolstofhoudend materiaal verarmd fluïdum, welke inrichting een hogedruk pomp omvat voor het onder hoge druk voeren van het te vergassen koolstofhoudend materiaalbevattende fluïdum naar een langwerpige buisvormige reactor met een eerste en een tweede uiteinde, waarbij het eerste uiteinde is voorzien van een inlaat voor het te vergassen koolstofhoudend materiaal bevattend waterig fluïdum, en het tweede  
35           uiteinde van een uitlaat voor het aan koolstofhoudend materiaal verarmde fluïdum, welke reactor is aangebracht in een kamer van een oven welke kamer van het lumen van de buisvormige reactor wordt gescheiden door een warmtegeleidende

reactorwand welke een behandelingstraject definieert, de oven aan de zijde van de uitlaat van de buisvormige reactor is voorzien van een eerste inlaat voor zuurstofomvattend gas en een tweede inlaat voor een brandstof en de kamer aan de zijde van de inlaat van de reactor is voorzien van een uitlaat voor verbrandingsproducten, en de uitlaat van de reactor is aangesloten op middelen voor het scheiden van door vergassing ontstaan brandbaar gas en aan koolstofhoudend materiaal verarmd waterig fluïdum.

13. Inrichting volgens conclusie 12, met het kenmerk, dat de inrichting een warmtewisselaar omvat voor het in tegenstroom voeren van uit de buisvormige reactor afkomstig aan te vergassen koolstofhoudend materiaal verarmd fluïdum en het te vergassen koolstofhoudend materiaal bevattende de waterige fluïdum.

14. Inrichting volgens conclusie 12 of 13, met het kenmerk, dat de inrichting een warmtewisselaar omvat voor het in tegenstroom voeren van via de uitlaat van de oven afkomstige verbrandingsproducten en na de eerste inlaat te voeren zuurstof omvattend gas.

15. Inrichting voor het thermisch behandelen van een te vergassen koolstofhoudend materiaalbevattende waterige vloeistof onder oplevering van een brandbaar gas en een aan te vergassen koolstofhoudend materiaalbevattende verarmde vloeistof, welke inrichting een vergassingsreactor omvat met een in hoofdzaak langwerpige eerste kamer en een in hoofdzaak langwerpige tweede kamer, de eerste kamer een toevoeropening voor de thermisch te behandelen te vergassen koolstofhoudend materiaalbevattende waterige vloeistof omvat, de eerste kamer en de tweede kamer van elkaar worden gescheiden door een warmtegeleidende wand, welke warmtegeleidende wand een behandeltraject definieert waarlangs de te vergassen koolstofhoudend materiaalbevattende waterige vloeistof en een door thermische behandeling aan te vergassen koolstofhoudend materiaal verarmde vloeistof na afscheiding van het brandbare gas in tegenstroom kunnen worden gevoerd, de inrichting verder middelen voor het scheiden van het brandbare gas en de door thermische behandeling aan koolstofhoudend materiaal verarmde vloeistof alsmede een afvoer voor het brandbare gas omvat, de

tweede kamer verder is voorzien van een inlaatopening voor het via een leiding en door middel van een pomporgaan onder verhoogde druk toevoeren van zuurstofomvattend gas aan de van het brandbare gas afgescheiden, door thermisch behandeling  
5 aan koolstofhoudend materiaal verarmde vloeistof, en een uit-  
laatopening voor een aan een thermische behandeling en een oxidatie onderworpen vloeistof.

16. Inrichting volgens conclusie 15, met het ken-  
merk, dat de middelen voor het scheiden van het brandbare gas  
10 en de door thermische behandeling aan koolstofhoudend materi-  
aal verarmde vloeistof een warmtewisselaar omvatten.

17. Inrichting volgens conclusie 15 of 16, met het  
kenmerk, dat de inrichting middelen omvat voor het verbranden  
van het brandbare gas onder oplevering van elektriciteit en  
15 warmte.

18. Inrichting volgens conclusie 17, met het ken-  
merk, dat de inrichting verder een warmtegeleidend oppervlak  
omvat voor het aan ten minste één kamer overdragen van bij de  
verbranding vrijgekomen warmte.

19. Inrichting volgens conclusie 18, met het ken-  
merk, dat de eerste kamer de tweede kamer in de lengterich-  
ting in hoofdzaak omgeeft, en het warmtegeleidende oppervlak  
20 de eerste kamer in de lengterichting in hoofdzaak omgeeft.

UITTREKSEL

De uitvinding heeft betrekking op een werkwijze voor het thermisch behandelen van te vergassen koolstofhoudend materiaalbevattende, waterige vloeistof onder oplevering van een brandbaar gas. Volgens de uitvinding geschiedt de omzetting van het koolstofhoudende materiaal tot brandbaar gas onvolledig, en wordt het nog niet omgezette koolstofhoudende materiaal geoxideerd door toevoer van zuurstof. De warmte die bij de oxidatie vrijkomt wordt benut voor het instandhouden van de vergassing. De uitvinding heeft tevens betrekking op een voor de werkwijze geschikte inrichting.

24.09.98

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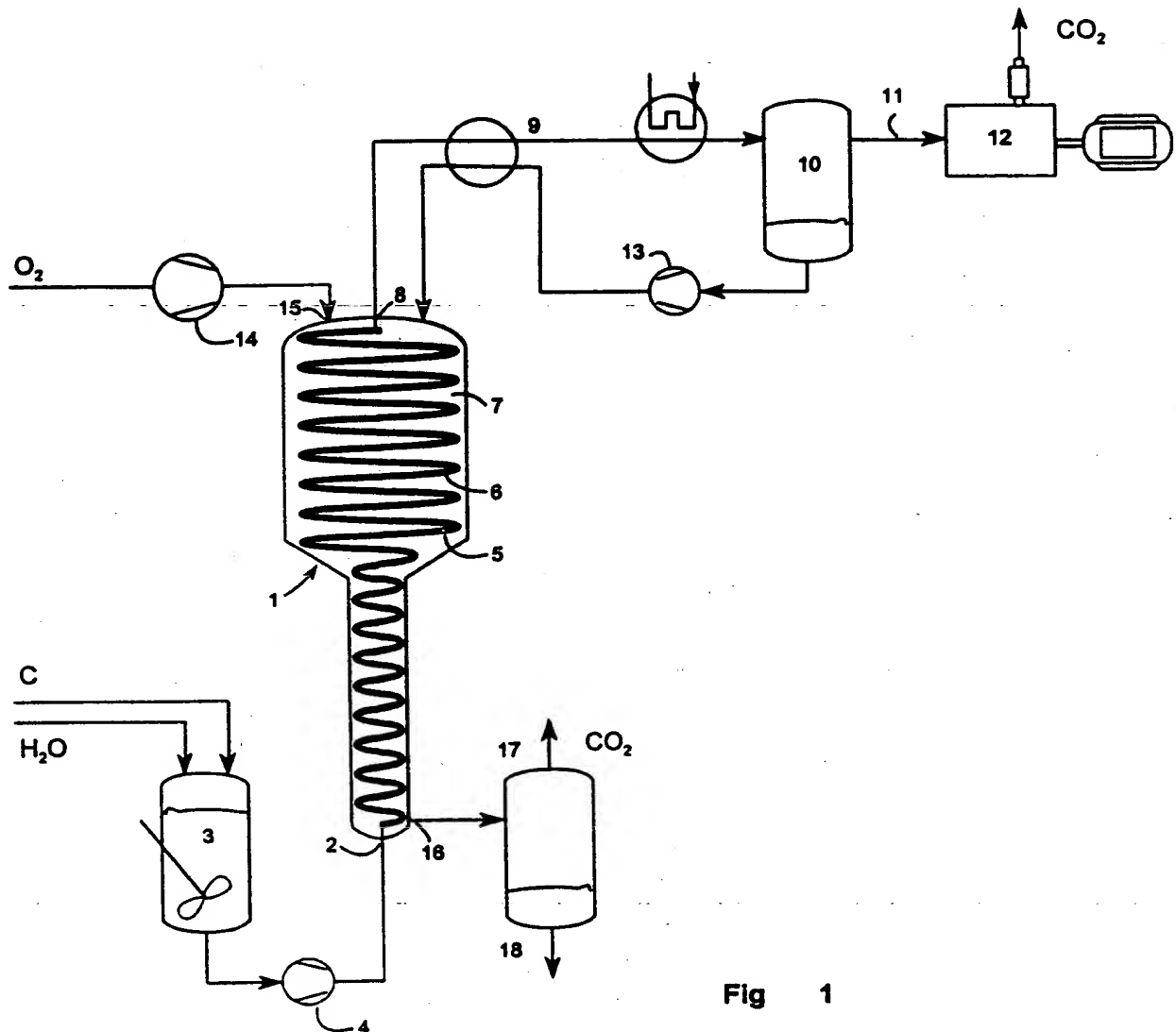


Fig 1



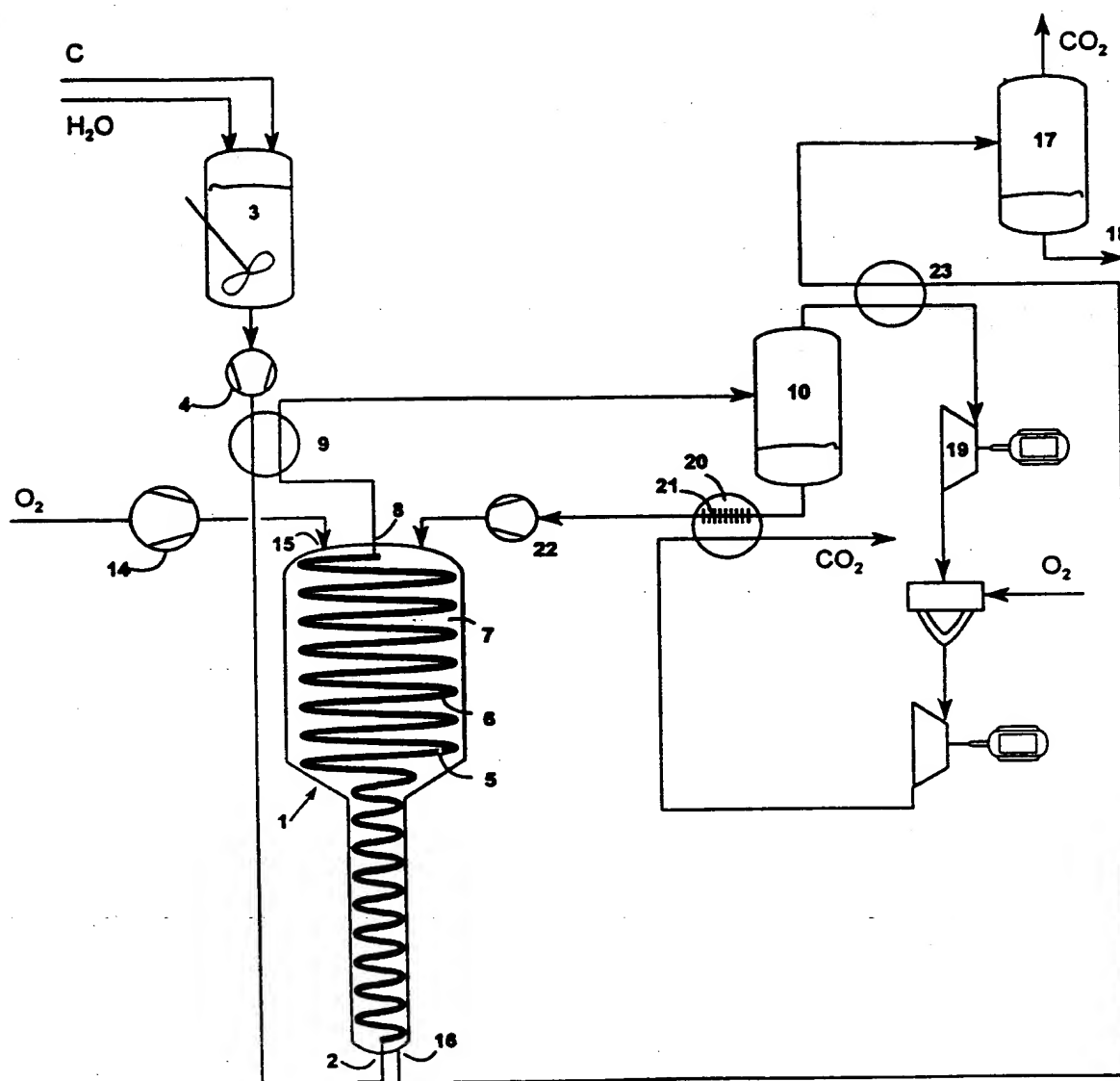


Fig 2

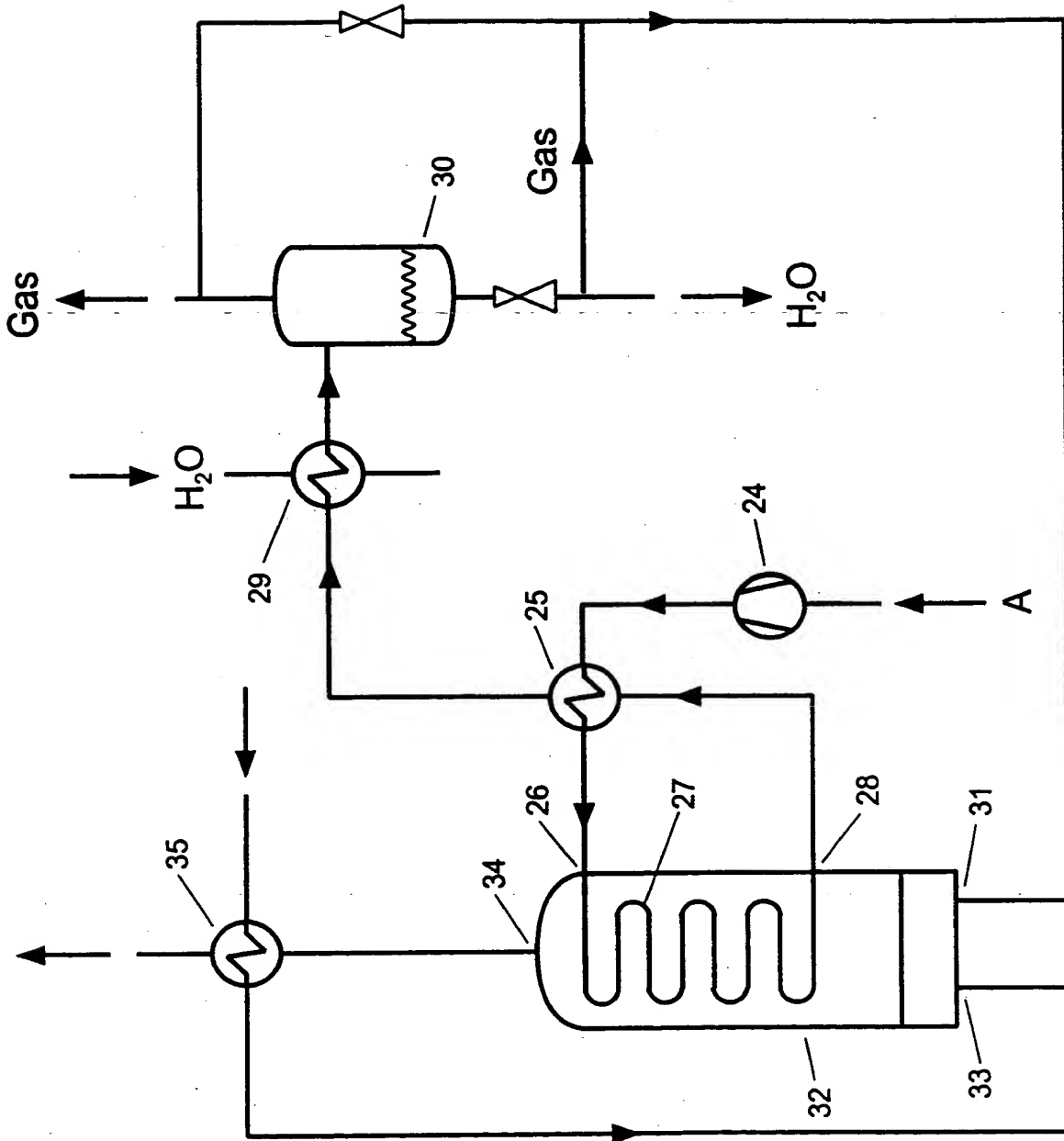


Fig. 3